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FACTORS OF EVAPORATION

Methods of Using them when Making Calculations for Boiler Tests

As is well known, the term horse power, when applied to a boiler, is different from that applied to an engine. In the latter case, the amount of work done in foot pounds per minute is the measure of the horse power of work performed, while in the case of a boiler, the number of pounds of water evaporated is a measure of the work done.

everybody adheres to the same standard. For instance: James Watt, in his day, estimated that a good horse could do 33,000 foot-pounds of work in one minute, and while it is now well known that a horse cannot do that much work, yet this standard has been adopted and adhered to during the past century.

When the committee of judges at the Centennial Exhibi-

FACTORS OF EVAPORATION.

Temp. of Feed.	Boiler Gauge Pressure; Pounds Per Square Inch.																			Temp. of Feed.
	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	150	160	
50	1.1987	1.2002	1.2016	1.2028	1.2040	1.2051	1.2062	1.2073	1.2082	1.2093	1.2103	1.2113	1.2122	1.2131	1.214	1.2148	1.2156	1.2171	1.2186	50
55	1.1935	1.1949	1.1963	1.1976	1.1988	1.1999	1.2010	1.2021	1.2032	1.2042	1.2052	1.2061	1.207	1.2079	1.2088	1.2097	1.2105	1.212	1.2135	55
60	1.1884	1.1898	1.1911	1.1924	1.1936	1.1948	1.1959	1.197	1.198	1.199	1.2	1.2009	1.2018	1.2027	1.2036	1.2044	1.2052	1.2068	1.2083	60
65	1.1832	1.1846	1.1859	1.1872	1.1884	1.1896	1.1907	1.1918	1.1928	1.1938	1.1948	1.1957	1.1966	1.1975	1.1984	1.1993	1.2001	1.2016	1.2031	65
70	1.178	1.1794	1.1807	1.182	1.1832	1.1844	1.1855	1.1866	1.1876	1.1886	1.1896	1.1906	1.1915	1.1924	1.1933	1.1941	1.1949	1.1964	1.1979	70
75	1.1728	1.1742	1.1755	1.1768	1.1780	1.1792	1.1803	1.1814	1.1824	1.1834	1.1844	1.1853	1.1862	1.1871	1.188	1.1889	1.1897	1.1912	1.1927	75
80	1.1676	1.169	1.1703	1.1716	1.1728	1.174	1.1751	1.1762	1.1772	1.1782	1.1792	1.1802	1.1811	1.182	1.1829	1.1837	1.1845	1.1860	1.1875	80
85	1.1624	1.1638	1.1652	1.1665	1.1677	1.1688	1.1699	1.171	1.172	1.1730	1.174	1.175	1.1759	1.1768	1.1777	1.1785	1.1793	1.1809	1.1824	85
90	1.1572	1.1586	1.16	1.1613	1.1625	1.1636	1.1647	1.1658	1.1669	1.1679	1.1689	1.1698	1.1707	1.1716	1.1725	1.1733	1.1741	1.1757	1.1772	90
95	1.152	1.1534	1.1546	1.1561	1.1573	1.1584	1.1595	1.1606	1.1617	1.1627	1.1637	1.1646	1.1655	1.1664	1.1673	1.1681	1.1689	1.1705	1.172	95
100	1.1469	1.1483	1.1496	1.1509	1.1521	1.1533	1.1544	1.1555	1.1565	1.1575	1.1585	1.1594	1.1603	1.1612	1.1621	1.1629	1.1637	1.1653	1.1668	100
105	1.1417	1.1431	1.1444	1.1457	1.1469	1.1481	1.1492	1.1503	1.1513	1.1523	1.1533	1.1542	1.1551	1.156	1.1569	1.1578	1.1586	1.1601	1.1616	105
110	1.1365	1.1379	1.1392	1.1405	1.1417	1.1429	1.144	1.1451	1.1461	1.1471	1.1481	1.149	1.1499	1.1508	1.1517	1.1526	1.1534	1.1549	1.1564	110
115	1.1313	1.1327	1.134	1.1353	1.1366	1.1377	1.1388	1.1399	1.1409	1.1419	1.1429	1.1438	1.1447	1.1456	1.1465	1.1473	1.1481	1.1496	1.1512	115
120	1.1261	1.1275	1.1288	1.1301	1.1313	1.1325	1.1336	1.1347	1.1357	1.1367	1.1377	1.1386	1.1396	1.1404	1.1413	1.1422	1.143	1.1445	1.146	120
125	1.1209	1.1223	1.1236	1.1249	1.1261	1.1273	1.1284	1.1295	1.1305	1.1315	1.1325	1.1334	1.1343	1.1352	1.1361	1.1370	1.1378	1.1393	1.1408	125
130	1.1157	1.1171	1.1184	1.1197	1.1209	1.1221	1.1232	1.1243	1.1253	1.1263	1.1273	1.1282	1.1291	1.1300	1.1309	1.1318	1.1326	1.1341	1.1356	130
135	1.1105	1.1119	1.1132	1.1145	1.1157	1.1169	1.118	1.1191	1.1201	1.1211	1.1221	1.123	1.1239	1.1248	1.1257	1.1266	1.1274	1.1289	1.1304	135
140	1.1052	1.1066	1.108	1.1093	1.1105	1.1117	1.1128	1.1139	1.1149	1.1159	1.1169	1.1178	1.1187	1.1196	1.1205	1.1214	1.1222	1.1237	1.1252	140
145	1.1	1.1014	1.1028	1.1041	1.1053	1.1065	1.1076	1.1087	1.1097	1.1107	1.1117	1.1126	1.1135	1.1144	1.1153	1.1161	1.1169	1.1185	1.12	145
150	1.0948	1.0962	1.0976	1.0988	1.1	1.1012	1.1024	1.1035	1.1045	1.1055	1.1065	1.1074	1.1083	1.1092	1.1101	1.1109	1.1117	1.1133	1.1148	150
155	1.0896	1.091	1.0924	1.0936	1.0948	1.096	1.0971	1.0982	1.0992	1.1002	1.1012	1.1022	1.1031	1.104	1.1049	1.1057	1.1065	1.1081	1.1096	155
160	1.0844	1.0858	1.0872	1.0884	1.0896	1.0908	1.0919	1.093	1.094	1.0951	1.096	1.097	1.0979	1.0988	1.0996	1.1005	1.1013	1.1029	1.1044	160
165	1.0792	1.0806	1.0819	1.0832	1.0844	1.0856	1.0867	1.0878	1.0888	1.0898	1.0908	1.0918	1.0927	1.0936	1.0945	1.0953	1.0961	1.0977	1.0992	165
170	1.074	1.0754	1.0767	1.078	1.0792	1.0804	1.0815	1.0826	1.0836	1.0846	1.0856	1.0865	1.0874	1.0883	1.0892	1.0901	1.0909	1.0924	1.094	170
175	1.0687	1.0701	1.0715	1.0728	1.074	1.0752	1.0763	1.0774	1.0784	1.0794	1.0804	1.0813	1.0822	1.0831	1.084	1.0848	1.0856	1.0872	1.0888	175
180	1.0635	1.0649	1.0663	1.0675	1.0687	1.0699	1.071	1.0721	1.0732	1.0742	1.0752	1.0761	1.077	1.0779	1.0788	1.0796	1.0804	1.082	1.0836	180
185	1.0583	1.0597	1.061	1.0623	1.0635	1.0647	1.0658	1.0669	1.0679	1.0689	1.0699	1.0709	1.0718	1.0727	1.0736	1.0744	1.0752	1.0768	1.0783	185
190	1.053	1.0544	1.0558	1.0571	1.0583	1.0595	1.0606	1.0617	1.0627	1.0637	1.0647	1.0656	1.066	1.0674	1.0683	1.0692	1.07	1.0716	1.0731	190
195	1.0478	1.0492	1.0506	1.0519	1.0531	1.0542	1.0553	1.0564	1.0575	1.0585	1.0595	1.0604	1.0613	1.0622	1.0631	1.0639	1.0647	1.0663	1.0679	195
200	1.0426	1.044	1.0453	1.0466	1.0478	1.049	1.0501	1.0512	1.0522	1.0532	1.0542	1.0552	1.0561	1.057	1.0579	1.0587	1.0595	1.0611	1.0626	200
202	1.0405	1.0419	1.0432	1.0445	1.0457	1.0469	1.048	1.0491	1.0501	1.0511	1.0521	1.0531	1.054	1.0549	1.0558	1.0566	1.0574	1.0590	1.0605	202
204	1.0384	1.0398	1.0411	1.0424	1.0436	1.0448	1.0459	1.047	1.048	1.049	1.05	1.051	1.0519	1.0528	1.0537	1.0545	1.0553	1.0569	1.0584	204
206	1.0363	1.0377	1.039	1.0403	1.0415	1.0427	1.0438	1.0449	1.0459	1.0469	1.0479	1.0489	1.0498	1.0507	1.0516	1.0524	1.0532	1.0548	1.0563	206
208	1.0342	1.0356	1.0369	1.0382	1.0394	1.0406	1.0417	1.0428	1.0438	1.0448	1.0458	1.0468	1.0477	1.0486	1.0495	1.0503	1.0511	1.0527	1.0543	208
210	1.0321	1.0335	1.0348	1.0361	1.0373	1.0385	1.0396	1.0407	1.0417	1.0427	1.0437	1.0447	1.0456	1.0465	1.0474	1.0482	1.049	1.0506	1.0522	210
212	1.03	1.0314	1.0327	1.0340	1.0352	1.0364	1.0375	1.0386	1.0396	1.0406	1.0416	1.0426	1.0435	1.0444	1.0453	1.0461	1.0469	1.0485	1.0501	212

For various commercial reasons, the horse power of a boiler is often rated according to the grate or heating surface which it contains, but no definite value can be given to these figures since they vary with different types of boilers and with the same types in different localities. By forcing the fires and consuming more coal, the evaporative power of a boiler may be increased so that the same size boiler in different localities may give widely different horse powers.

For practical purposes, it does not usually matter very much what the standard of horse power of a machine is, so long as

tion, to whom the trials of testing the boilers at that exhibition were intrusted, attempted to compare the horse power of the various boilers, they found that each builder had practically his own rating and since many contracts depended upon the full understanding of the words horse power, they determined what evaporation of water was average practice. This committee determined that their standard for one horse power would be 30 pounds of water evaporated from a feed water temperature of 100 degrees into dry steam at 70 pounds gauge pressure per hour.

This was in the year 1876 and when the question was taken up in 1884 by the committee of the American Society of Mechanical Engineers on Trials of Steam Boilers, they decided to accept the Centennial standard and recommended that in all standard trials, the commercial horse power be taken as an evaporation of 30 pounds of water per hour from a feed water temperature of 100 degrees into steam at 70 pounds per square inch gauge pressure, which shall be considered to be equal to 34.5 pounds of water evaporated from a feed water temperature of 212° Fahrenheit into steam at the same temperature. This unit of power is equivalent to 33,305 heat units per hour, or equivalent to 965.7 heat units per pound of water evaporated "from and at 212 degrees."

In practice, it is found that for every boiler different conditions prevail, so that the number of heat units which are absorbed by the boiler under the actual conditions must be found and compared with the standard. The factor of evaporation is then obtained by dividing the heat which is necessary to raise a pound of water into steam under the test condition by 965.7. A table of evaporation factors is given herewith which gives the factors of evaporation for various conditions of steam pressure and feed water temperature.

The application of the table to boiler tests is shown by the following problem: A boiler is found to evaporate 4620 pounds of water in one hour when the feed water temperature averages 202 degrees and the gauge pressure is 105 pounds. What horse power is the boiler developing? Referring to the table, in the 105 pound column and opposite the feed water temperature of 202 degrees is found the factor of evaporation, 1.0511. Multiplying the pounds of water evaporated by the factor of evaporation, it gives the number of pounds of water which would be evaporated from and at 212 degrees by the application of the same amount of heat, or, $4620 \times 1.0511 = 4856.08$ pounds. Since the evaporation of 34.5 pounds of water per hour from and at 212 degrees is equivalent to one horse power, the horse power of the boiler working under the given conditions will be $4856.08 \div 34.5 = 140.7$ horse power.

The table of evaporation factors is not only useful when making boiler tests or when finding the horse power of the boiler working under various conditions, but it is also useful in finding the extra amount of fuel that will be saved by heating the feed water. For instance: Suppose the feed water temperature is 120 degrees and the steam pressure 100 pounds gauge; what economy would there be if the feed water was heated to 208 degrees? In the first case, with the feed water 120 degrees and boiler pressure 100 pounds, the factor of evaporation would be 1.1357, and with the same boiler pressure, but feed water temperature 208 degrees, the factor of evaporation would be 1.0438. By dividing 1.0438 by 1.1357, the percentage of the amount of combustible necessary will be obtained, or $1.0438 \div 1.1357 = 91.9$ per cent. This means that with all other conditions the same, for every 100 pounds of combustible that will be necessary when the feed water is 120 degrees, only 91.9 pounds will be necessary when the temperature of the feed is 208 degrees.

ROTARY CONVERTER OPERATION

Three Methods of Starting this Type of Motor-Generator

At the present time, aside from the mercury vapor rectifier which has just come into use in small sizes for rectifying alternating current, the only practical method of transforming large quantities of alternating current into direct current, or direct current into alternating current, is by means of a rotary converter. This machine is in reality a combination of a motor and a generator and when used to convert alternating current into direct current it acts as a synchronous motor driving a direct current generator. It can, however, just as readily be used as a direct current motor driving an alternating current dynamo.

It has its largest use in substations of an alternating current plant where alternating currents are generated at a high voltage and direct current at a low voltage is needed. The substation which contains the rotary converter is often miles away from the generating station, so that the transmission of high voltages is necessary for the sake of economy and the direct current is made available almost at the exact point of distribution. Many trolley roads are now making use of this system of distribution and instead of generating the 550 volt direct current and distributing it to various sections of the road over large feeders, alternating current of from 6000 to 11,000 volts is generated and sent to the substations for conversion and distribution.

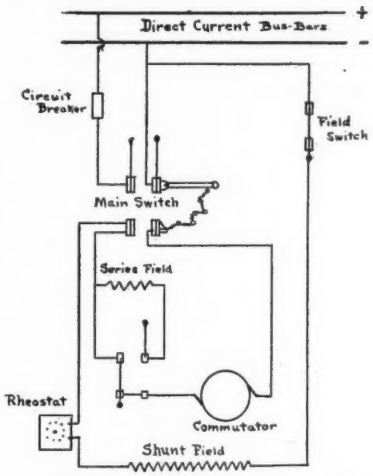
There are three possible ways of starting up a rotary converter: (1) From the alternating current side; (2), from the direct current side, and (3) by the use of an auxiliary alternating current starting motor. When started from the alternating current side, it is necessary to have a field-splitting switch in order that the shunt winding may be opened before starting, otherwise the insulation would break down owing to the excessive electro-motive force induced at the moment of closing the alternating main switch. If the rotary converter is compound wound, the series field windings must also be open circuited.

All switches on the direct current side must be left open before switching the rotary on the alternating current line. By reason of the hysteresis lag in the pole faces, and in a lesser degree due to the eddy currents set up, the rotary will start as soon as the alternating switch is closed, and will immediately run up to synchronous speed. As soon as synchronism is attained, the field-splitting switch and the direct current field switch can be closed. With selfexciting sets care must be taken to see that the field switch is closed, so that the machine is building up the right polarity. The reading of the direct current voltmeter will indicate this. The rotary, which is now running in synchronism with the main generators, can now be paralleled on the low tension bus-bars in the usual way.

This method has some serious disadvantages, principally on account of the large current at low power factor which it draws from the supply lines and the possibility of generating direct current of the wrong polarity. For traction work this

method has been employed, but should not be used on lighting circuits.

To start a converter from the direct current side, first see that all switches are open, that the direct current brushes are all properly set and that the series field is cut out or short-circuited. Next, close the alternating current circuit-breaker and positive switch. Close the field switch with all the rheostat resistance cut out and try the field coils to see that they are magnetized. Now, start the converter as a direct current motor by cutting out the starting resistance slowly; when



1. Connections for Starting Rotary Converter from Direct Current Side.

this is cut out, close the negative switch. Then adjust the speed to synchronism by means of the field rheostat and the synchronizing lamps. It is also necessary to have the alternating current voltage of the rotary converter equal to the voltage of the mains. Shifting the brushes will assist in making this adjustment.

When the voltage is correct and the lamps indicate the proper phase relations, close the alternating current switches and adjust the rheostats for minimum alternating current and set the direct current brushes at a non-sparking position. The connections of the direct current side are shown in Fig. 1.

The third method consists in starting up the converter by means of an alternating current starting motor. In following this method, see that the alternating current and direct current brushes are all in their correct position and see that all switches are open on both the alternating and direct current sides and that the resistance of the rheostat is all in the field circuit. Close the alternating current main circuit-breakers and see that the synchronizing lamps, or synchronoscope are in and that the lamps burn dimly, and that the direct current voltmeter is in circuit.

Start the rotary by closing the starting switch for the small motor and build up the direct current voltage by cutting out resistance in the rheostat until the voltage is equal to the bus-bar voltage. Note the synchronizing lamps and adjust the speed by means of the field rheostat until the lamp dims slowly and regularly. It may be necessary to shift the direct current brushes back to the neutral point in order to get the proper speed. When the lamps show pulsations at the rate of about every ten seconds, the alternating main switch should be closed quickly when the lamps are getting dark. Now open the starting motor switch and adjust the converter field excitation so as to get minimum current in the alternating current ammeters. Next close the direct current circuit-breakers and switches and see that the brushes are in the proper position.

The starting up of synchronous motor sets presents no especial difficulty and is often done from the direct current side, synchronizing on the alternating side as described. For lighting systems, the starting current required for large units, according to this method, might occasion a heavy drop on the distributing mains, so that it will become necessary to use either an induction motor-generator set to supply the necessary direct current or, the use of a small induction motor for starting the set will be necessary, as described in the third method above.

To shut down a rotary converter, which is operating in the usual manner, simply open the direct current circuit-breaker and the direct current switches; then open the alternating current switches; cut in all the field rheostat and pull out the synchronizing plugs.

Wear on Turbine Blades.

The firm of Sulzer Bros., the famous German builders of steam engines, have conducted extensive experiments upon the wear of the blades of steam turbines, to determine the cause of the trouble. It is undoubtedly a fact that the continued success of the turbine hinges largely upon this one point of wear. If the blades of a particular machine should have to be renewed frequently, because of deterioration and consequent loss in economy in the use of steam, that turbine would not make a commercial success. The Sulzer experiments indicate that the wear is due to the particles of water in the steam and that if water is present in steam that flows at extremely high velocities, as is the case in single-stage turbines, the cutting is apt to be rapid. With superheated steam, or with saturated steam in multi-stage turbines, the cutting is not a serious matter.

The above experiments are in a measure confirmed by the experience of those using steam injectors for boiler feeding. This cutting action seldom occurs in the steam nozzle, but frequently does take place in the combining tube where water is flowing at comparatively low velocities. It should be noted, however, that this water is mainly the feed water pumped up by the injector, and contains more or less mineral matter, the extent of the cutting probably depending upon the quantity of such foreign particles entrained in the water. In the case of the turbine, however, the water particles suspended in the steam are or should be nothing but distilled water, formed by steam condensation after leaving the boiler. Probably no injector would give trouble by cutting, if used to pump distilled water, assuming, of course, that the tubes were of a material that would not be corroded by water. We also believe that no turbine, in which steam is used at a moderate velocity, will be likely to deteriorate rapidly under ordinary operative conditions.—*Machinery.*

In testing engines for economy, it is necessary to determine the amount of moisture of the entering steam. Without such a determination, no proper idea can be obtained of the amount of steam actually used by the engine per horse power, as the steam may contain a large amount of moisture in the form of spray.

RIVETS AND RIVETED JOINTS

There are two methods by means of which boiler plates may be joined together: by welding and by riveting. If it were possible, all joints in a steam boiler would be welded, but owing to practical difficulties, the latter method is now confined to the manufacture of tubes, flues and cylindrical fireboxes for internally fired boilers. Notwithstanding, however, the many disadvantages of the riveted joint in the matter of cost, inherent weakness by the reduction of area of the plate and bad workmanship which cannot be detected, it has become one of the most important details in boiler making.

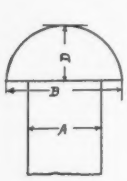


Fig. 1.

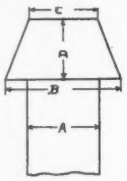


Fig. 2.

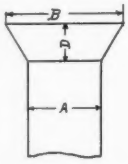


Fig. 3.

Fig 4.

The requisites for a good joint are: strength to resist the strain from internal pressure; tightness against leakage of water or steam; ability to withstand heat; ability to undergo contraction and expansion without injury. If welding could be used, it would make the joint nearly as strong as the rest of the plate; the plate would be no thicker at the joints than elsewhere; no rivets would be required, which would make the boiler tighter and less likely to leak, as a good welded seam is water-tight and needs no caulking. The reason why they are not used is the difficulty of getting the proper facilities for making a good joint, which at the present time makes them costly. One of the principal objections to the welded joint is that the joint may not be welded properly, in which case it will be water-tight and yet be far from having full strength and be very much harder and unsatisfactory to detect than a riveted joint. The riveted joint has therefore met the requirements of a boiler joint, inasmuch as it is strong, water-tight and comparatively cheap.

The total strength of a plate in a riveted joint will be lessened by that area of metal taken from it to supply places for rivets. In a good quality of wrought iron, punching, if properly done, has little or no effect upon the plates, and no other loss occurs than that due to reduction of area along the line of rivet holes, so that the net strength of what remains of an iron plate, whether punched or drilled, is equal to that of the original plate for a corresponding sectional area; but in the case of steel plates, the value of the net sectional area remaining between the rivet holes is somewhat uncertain. Whatever loss of strength has been found to take place in a steel plate, it can generally be restored by reaming or by the annealing effect produced by the hot rivets, so that it is usual to assume in ordinary calculations that the net section between the holes is equal to that of the original plate for the same area of cross-section.

The holes for rivets are either punched or drilled. Punching is more quickly accomplished than drilling and is cheaper, while drilling does less harm to the plate and the holes are likely to match better. The plan of punching and reaming is often used, since punching offers the advantage of rapidity and cheapness, while the reaming leaves no deteriorated metal.

At the present time, almost all boiler plates are made of mild steel and in order that the plates have the required strength and ductility, it is usually demanded that the name of the maker be stamped on each plate, together with the tensile strength, as determined by a test in a proper testing machine. Bending tests are also required to prevent the presence of carbon and phosphorous. For thicknesses of three-quarters of an inch and under, the plate should bend double, both hot and cold, under a heavy hammer without showing cracks at the bend, and thicker plates should bend with a radius equal to their own thickness at the inside without showing distress. The tensile strength should vary from 52,000 to 62,000 pounds per square inch, but in all rivet-joint calculations the tensile strength is usually taken as 55,000 pounds per square inch.

The tensile strength of open-hearth steel rivets is about 52,500 pounds per square inch. The elastic limit must not be less than one-half the ultimate tensile strength, according to the standard specifications. The shearing strength, as found from a large number of experiments, is about 85 per cent. of the tensile strength. The rivets should answer to the following tests: Bent cold in the form of a hook without showing cracks or flaws; bent hot in the form of a hook with parallel sides without showing cracks or flaws; the heads should hammer hot to form a disc 2½ times the diameter of the shank, without cracking at the edges; the shearing test to consist of riveting 2 bars of steel by a single rivet and submitting it to a tensile strain, the rivet not to shear under a stress of less than 45,000 pounds per square inch.

Dimensions of Rivet Heads.

Diameter of Rivet	Button-Heads Fig. 1.		Cone-Head Fig. 2.			Countersunk-Head Fig. 3.	
	Diam.	Thickness	Diam.	Diam.	Thickness	Diam.	Thickness
A	B	D	B	C	D	B	D
5/8	1 1/16	7/16	1 1/16	9/16	9/16	1 1/16	1/4
11/16	1 1/8	1/2	1 1/8	5/8	5/8	1 3/16	5/16
3/4	1 1/4	9/16	1 1/4	11/16	11/16	1 1/4	3/8
13/16	1 3/8	5/8	1 3/8	3/4	3/4	1 5/16	7/16
7/8	1 7/16	3/4	1 7/16	13/16	3/4	1 3/8	7/16
15/16	1 9/16	3/4	1 9/16	7/8	13/16	1 1/2	1/2
1	1 5/8	3/4	1 5/8	15/16	7/8	1 5/8	1/2
1 1/16	1 11/16	13/16	1 3/4	1	7/8	1 3/4	9/16
1 1/8	1 3/4	7/8	1 13/16	1 1/16	15/16	1 7/8	9/16

Rivets are made with different kinds of heads and the accompanying table gives the dimensions of three kinds of rivet heads in use. Fig. 1 represents a button-head rivet; Fig. 2, a cone-head rivet and Fig. 3 a countersunk-head rivet. In hand riveting the points are generally made conical, as shown in Fig. 4, but in machine riveting the button-head is usually used.

In ordinary boiler construction, four types of riveted joints are employed: single riveted lap, double riveted lap, butt-joint with single strap, butt-joint with double strap. These are shown in the accompanying illustrations. Fig. 5 represents a

single riveted lap joint; Fig. 6, a double riveted joint; and Fig. 7, a butt-joint with double strap.

There are two methods of making a joint: either by using the zigzag method or the chain method of riveting. Zigzag riveting is that arrangement of rivets in which one row is

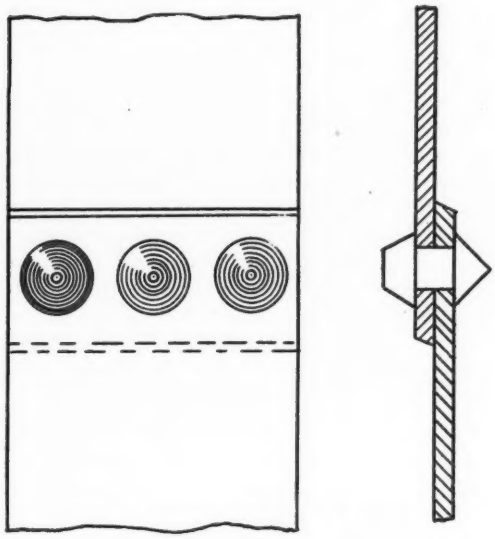


Fig. 5.

placed between the centres of the next row and is the style of riveting almost universally used. Chain riveting is that arrangement of rivets in which one row is placed exactly behind the other.

Investigations into the strength of riveted joints have been made by actually pulling a joint apart upon a testing machine

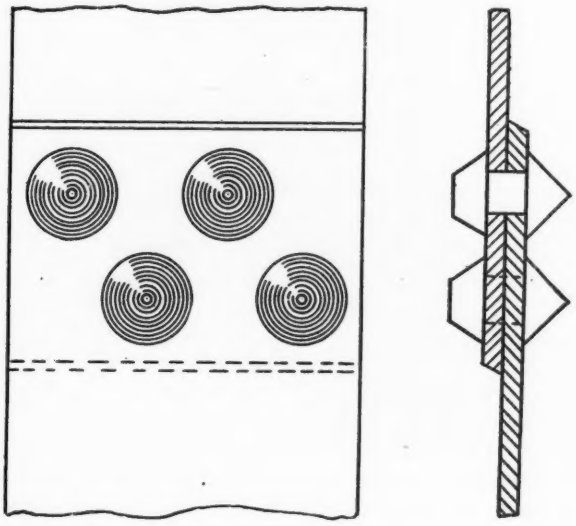


Fig. 6.

and it has been found that a riveted joint will fail either by the shearing of the rivets, by the crushing and tearing out of the plates in front of the rivets or by tearing the plate along the lines of the rivet holes. When shearing of the rivet takes place, it is because the rivet area is too small for the thickness of the plate and pitch of rivets. When the plate fails by crushing and tearing out of the rivets, it is usually because the rivets are too large or they are placed too close to the edge of the plate. When a riveted joint fails by the fracturing of the plate along the line of rivets, it indicates that the joint was proportioned properly and that the maximum strength of the joint has been attained.

Of the various kinds of riveted joints in use, the single-riveted lap joint is the simplest. Its efficiency is usually about 60 per cent. of the strength of the solid plate. Single riveting is little used in longitudinal seams, except for small boilers and low pressures; but single riveted joints are in common use for circumferential seams in steam boilers.

A double riveted joint is stronger than a single riveted joint, because the wider spacing and pitch of the rivets give a larger net section of the boiler plate, larger surfaces of frictional contact, and a larger rivet area under shearing stress. Longitudinal seams in steam boilers should at least be double riveted; no plates less than ¼-inch thick, and no rivets less than ⅝-inch in diameter, should be used. The percentage of strength of a double riveted joint is about 70 per cent.

Butt-joints are commonly used for plates ⅜-inch thick or

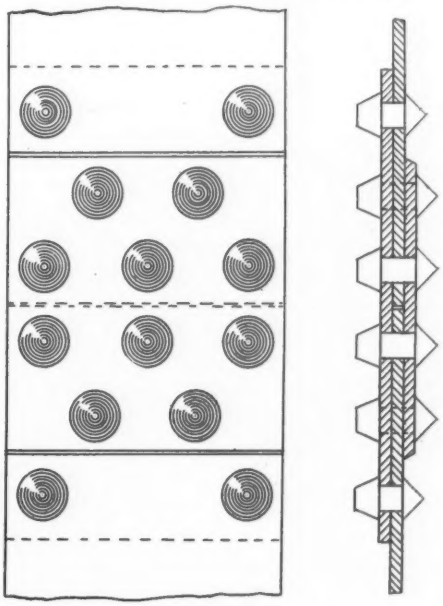


Fig. 7.

over. The plates to be joined are placed edge to edge with outer and inner welt-strips, the whole secured by through going rivets, as shown in Fig. 7. The *U. S. Rule* for butt-straps is as follows: "Where butt-straps are used in the construction of marine boilers, the straps for single butt-strapping shall in no cases be less than the thickness of the shell-plates; and where double butt-straps are used, the thickness of each shall in no case be less than five-eighths (⅝) the thickness of the shell-plates." The percentage of the strength of a butt-joint with double welts is about 85 per cent. of the strength of the plate.

Foaming in a boiler can be checked by feeding strongly and blowing out, by throwing off some of the load on the engine, by changing the feed water, or by deadening the fire. At the first opportunity, the boiler should be emptied and cleaned.

LATEST TYPES OF AMERICAN STEAM ENGINES

The American Ball High-Speed Engines

For many purposes, especially in electric lighting and power fields, it is considered best practice to install direct connected high-speed engines. The first cost of this type of engine is not only less than that of other types, but it also takes up less space, and, because the engine makes a high number of revolutions per minute, each revolution is made in a fraction of a second and consequently any change in the load upon the engine is promptly met and is less noticeable than in an engine of slower rotating type. This means that a variable load and the crank effort are almost constantly in equilibrium.

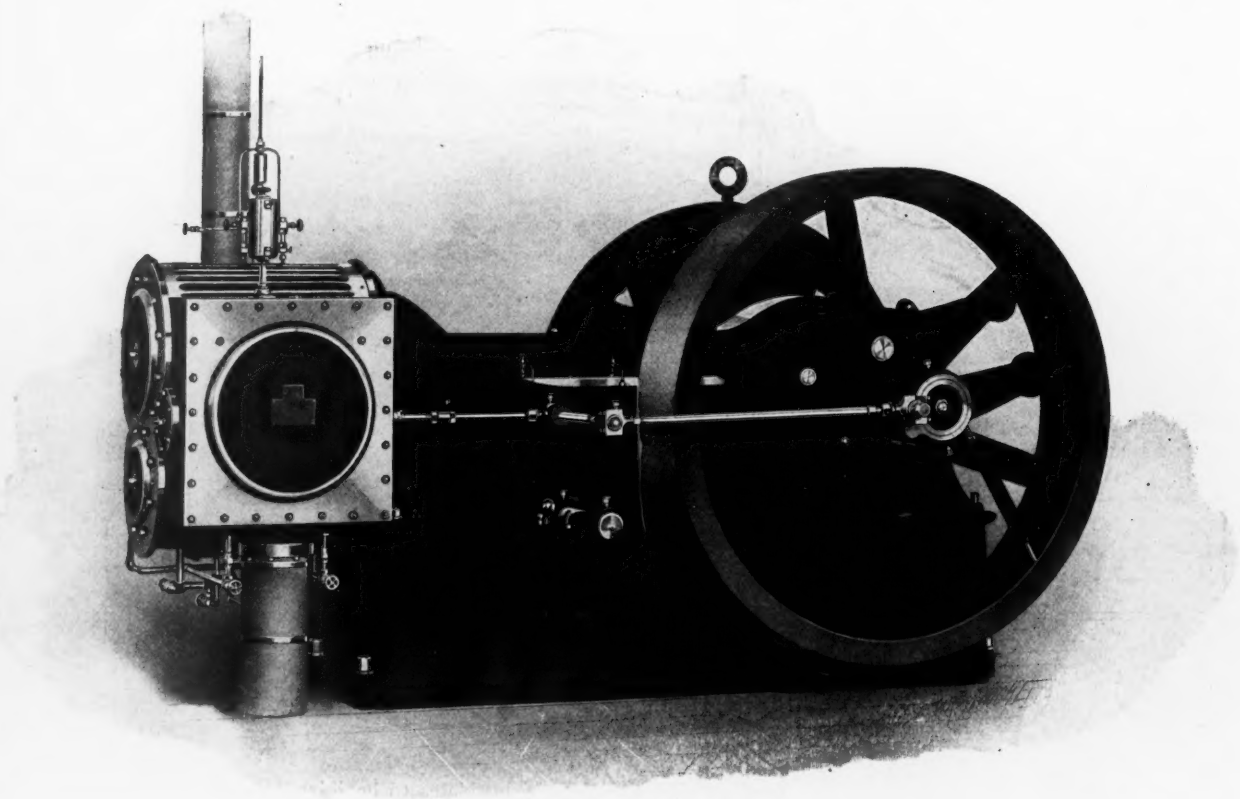


Fig. 1.—Governor Side of American Ball Engine.

The American Ball engine represents one of the most advanced types of high-speed engines in which there are many new and desirable features combined with a standard design which has stood the test of time. The accompanying illustration, Fig. 1, shows the governor side of the simple engine, the particular features of which are the construction of the valve, the governor and the system of oiling.

The valve, shown in Fig. 2, consists of two parts which are in reality two valves with telescopic sleeves connected back to back and forming a continuous passage, the two faces of the valve performing similar functions on opposite seats in the steam-chest. These seats are duplicates of each other. When steam is admitted through the central opening on the top of the steam-chest into the interior of the valve, there is an uninterrupted communication from the boiler to this opening. The faces of the valves are held in contact with their corresponding seats by steam pressure and the diameter of the telescopic sleeves therefore determines the pressure of contact. In practice, a diameter of sleeve is selectd which insures positive contact between the valve and its seat in all positions without undue friction and the telescopic action insures a continuous contact with a minimum of wear which is "taken up" automatically.

The particular advantages of this valve are that it is free from destructive friction, because it is balanced, and at the same time is constructed so that leakage of the steam is a minimum in the valve itself. This valve is not new but it has been in use in all these engines for nearly twenty-five years.

The governor is also a feature which makes this engine prominent, for in these days of close regulation it is necessary that a governor should have almost human intelligence. Mr. Frank Ball has here shown his engineering skill and has produced a governor which is not only stable but isochronous. To do this, two pivoted parts are used, both of which utilize

angular inertia as a governing force. Referring again to Fig. 1, it will be noticed that one of the parts with the spring is located so that centrifugal force can be used to the best advantage, while the other part is pivoted at the most desirable point for determining the path of motion of the valve actuating pin. This latter pivoted part, which is the upper arm in the illustration, is located so that its centre of gravity and the centre of shaft practically coincide, a condition which permits of no centrifugal force affecting the valve mechanism.

As the force of gravity acts on both these pivoted masses to turn them about their pivots, they oppose each other at every position of the wheel so that a gravity balance is always had. This arrangement, therefore, not only prevents any oscillation when running but prevents the noise attending the starting and stopping of an unbalanced engine governor. The regulation from no load to full load of the latest types of engines which have been equipped with these governors has been as small as one-third of one per cent., and even smaller, when the whole load was thrown on or off suddenly.

The self-oiling system is another admirable feature of this excellent engine, by means of which the shaft journals and crank-pin are oiled automatically. To perform this system of lubrication there is a storage tank of oil located underneath the rock-shaft bracket and a pump of particular construction is placed in this tank. The plunger of the pump is a small steel rod which works in a brass tube. The plunger is driven by a connection with the rock-shaft, and a helical spring coiled around the barrel and attached to the plunger prevents noise from lost motion. The pump can be operated by hand at any time by unhooking from the rock-shaft.

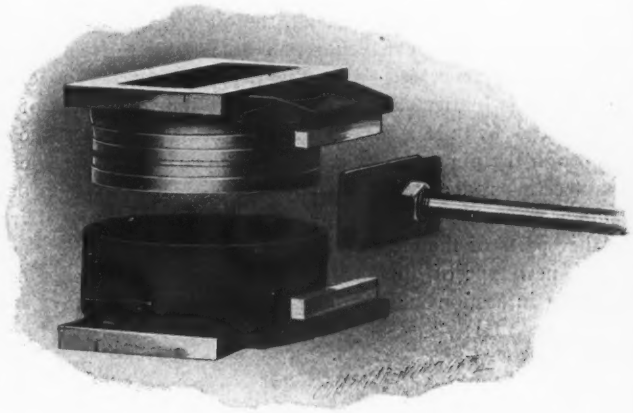


Fig. 2.—Valve Used on Simple Engines.

Suitable pipes lead from the pump to the pillow-blocks, and to both the guides, where adjustable discharge nozzles deliver the oil in a regulated stream to the working surfaces. A circular oil-channel is cut in the side of each crank for receiving the oil that escapes from the pillow-blocks, and by means of suitable holes drilled diagonally through each crank

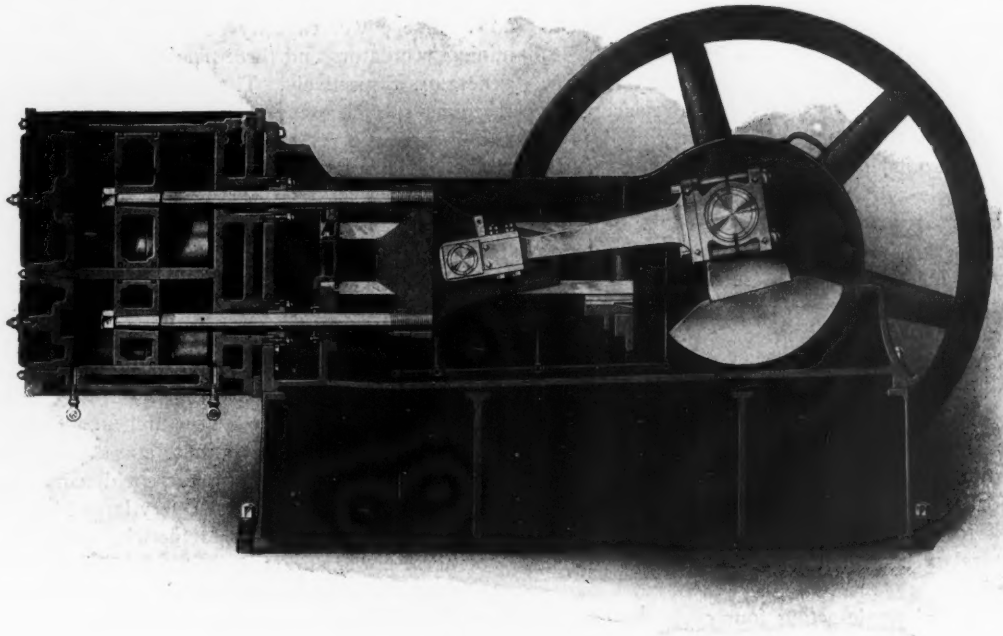


Fig. 3.—Section of American-Ball Duplex Compound Engine

To complete the oiling mechanism, a small air-chamber is attached to the discharge pipe just above the pump, and a small relief valve allows the surplus oil to escape and fall back into the reservoir. To provide for emergencies, a gravity receptacle with a pipe of suitable length is provided, and in case of any derangement of the pump, the air-chamber can be unscrewed and the gravity receptacle set in its place, thus continuing the supply of oil until a convenient time to examine the pump and remedy the difficulty.

to the pin, the oil is fed to the connecting-rod box.

This circular hole is not concentric to the shaft, which insures a rapid flow of oil by centrifugal force to that part of the channel farthest from the shaft, where it is discharged through the hole to the crank-pin. Collars are placed on the

shaft at the outer ends of the pillow-blocks to receive the surplus oil escaping in that direction and discharge it, by centrifugal force, into an encircling chamber in the pillow-blocks, whence it flows by gravity through a channel into the interior of the engine-frame and from there it flows by gravity to the storage-tank.

On entering the storage-tank, the oil passes through a fine wire gauge strainer which removes everything from the oil that can be separated from it without filtering. The crosshead pin is lubricated with oil from the upper surfaces of the crosshead by means of suitable holes that conduct the oil through the pin and deliver it on its upper surface inside the connecting-rod box. The stream of oil which flows through these channels returns to the storage tank with the oil from other parts of the engine.

A new type of duplex American Ball compound engine is shown in section in Fig. 3. Its most distinct features, apart from those described in the simple engine, are its compactness and simplicity. It requires no more floor-space than a simple engine and the valve-gear has but one valve and rod. The valve used in this engine is a form of piston-valve which provides a means for adjusting the wear. The wear of a piston-valve in a horizontal engine occurs on the lower half and is caused by the friction due to the weight of the valve.

The effect of this is to form an oval-shaped hole and the valve always lies against the bottom element and, if provision is not made to take up the wear, there will be leakage through the crescent-shaped opening over the upper half of the valve. To take care of this wear, the piston valves in these engines are split horizontally so that the upper half may be separated from the lower, and by the use of liners between the two halves, the valve can be made oval in shape to fit the bore.

The manufacturers of the American Ball engines are the American Engine Co., of Bound Brook, N. J.

MODERN HIGH-POWER GAS ENGINE PLANTS

By Frank C. Perkins.

The high-power gas engine is now being extensively employed in America as well as in Europe for the operation of blowing engines in the large power plants of iron and steel works, as well as for driving electrical generators supplying current to the electrically operated machines throughout these large plants and yards. A large proportion of the great internal combustion engines now being built in the United States for utilizing the waste blast furnace gases and coke oven gases are of German design but are constructed in this country to avoid the payment of the high tariff. The economy of these engines is very high and in many cases they are replacing the large steam engines heretofore almost exclusively used.

Among the more prominent German gas engines of the single acting and double acting types of two cycle and four cycle design constructed for large powers should be mentioned the Oechelhauser gas engine—one of which is shown in the accompanying illustration. The Oechelhauser gas engine here shown is a 1000 horse power twin engine directly connected to an alternator in the power house of iron and steel works at Differdingen, Germany.

The double acting two cycle engines are well represented by the Koerting engines installed largely in German steel plants as well as in the largest gas engine steel plant power power house in the world, at Buffalo, where, at the Lackawanna Steel Works, sixteen 2000 horse power blowing gas engines and eight 1000 horse power gas engines for driving electrical generators of both alternating and direct current type are in operation.

The double acting and single acting four cycle gas engines for blast furnace gases of prominence include the Nurnberg and Augsburg types as well as those of the Deutz type. The engineers of the latter company have installed two 1000 horse power four cycle engines and two 600 horse power machines driving alternating current generators of the three-phase type, at the power house at Dudelingen, Germany, shown in the accompanying illustration. The alternators operate at 132.6 and 140 revolutions per minute, supplying 164 amperes and 106 amperes at 3000 volts pressure, the larger alternators having a capacity of 492 kilowatts and the smaller machines an output of 316 kilowatts.

Double acting Deutz blast furnace gas engines operating blowing engines have recently been installed at German power houses, one plant having a capacity of 1400 horse power and at the mining power plant at Hoerde, gas engines of 200 and 2000 horse power capacity have been installed for operating mining ventilators and three-phase alternating current electric generators respectively. The double acting gas engine is now receiving special attention for this class of service.

For driving a rolling mill at Burbach, a 1500 horse power tandem double acting four cycle gas engine of the Nurnberg type has been installed for working on waste blast furnace gases and has been giving excellent service since June, 1904. This engine operates at a speed of 90 revolutions per minute and is doing service such as heretofore only high power steam engines have been used for. A 500 horse power single acting four cycle engine has been utilized for some time at the rolling mills of Frederick Krupp, at Essen.

In August, 1904, two 1800 horse power double acting gas engines were installed at Gelsenkirchen. These engines operate at 64 revolutions per minute and are directly coupled to direct current and alternating current dynamos, the total output being 3600 horse power. A very large blowing engine has also just been installed at Meiderich, having a capacity of 3200 horse power at 80 revolutions per minute, while a similar engine has also been in operation for some months at Volkingen, at the power house of the Rochlongsche Iron and Steel Works.

In iron and steel plants where a larger amount of power is required than it is possible to develop by burning the entire waste gases from the blast furnace plants under boilers, it is found necessary to use coal for developing the extra power. Otherwise a part or all of the waste gases may be used directly in high power gas engines. The prominent American engineers manufacturing the Nurnberg gas engine in the United

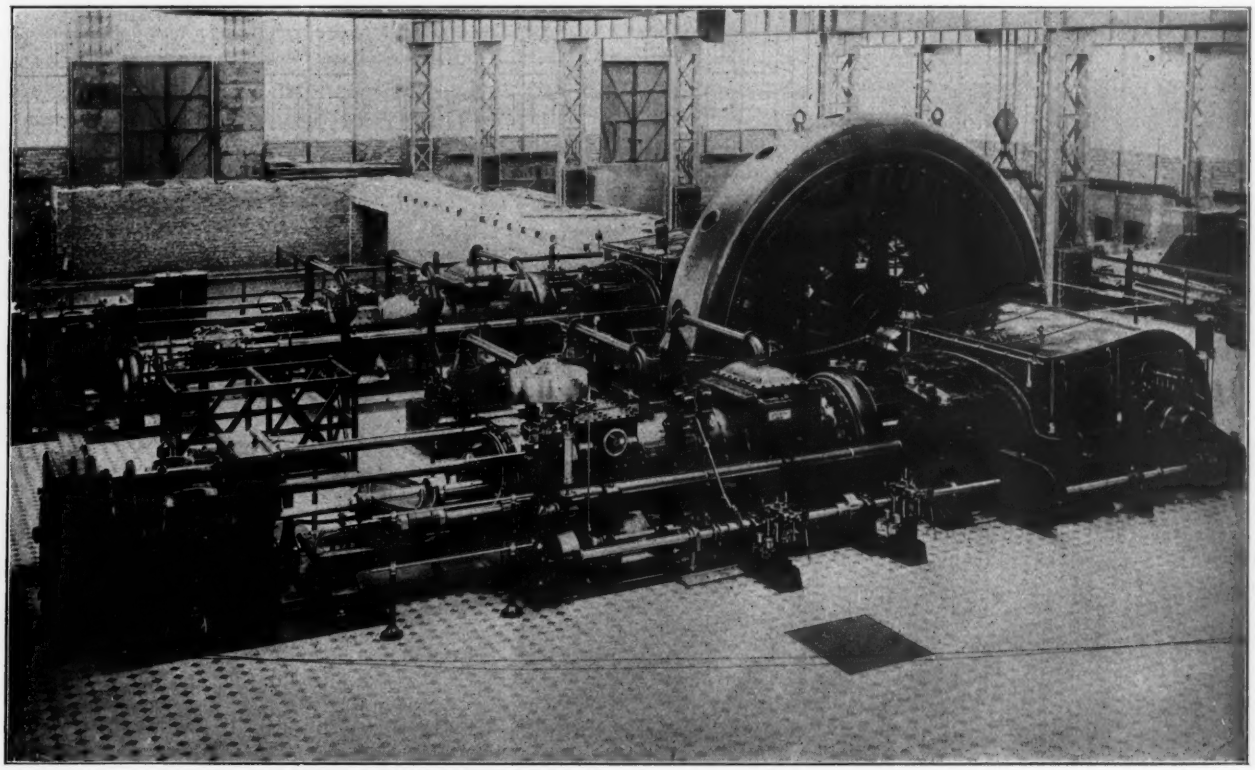
States, state that in a blast furnace, gas is generated to an amount exceeding 100,000 cubic feet per ton of pig-iron produced, having a heat value of 85 British Thermal Units per cubic foot. About 70,000 cubic feet of this gas are utilized in heating the blast and about 90,000 cubic feet of gas remain available for power generation.

The power required to operate the blast furnace plant, that is: the power consumed by the blowing engines, pumps, mechanical charging apparatus, etc., amounts to about 10 brake horse power per ton of pig-iron produced per 24 hours, or 240 brake horse power per hour per ton of pig-iron. Taking as a basis of comparison, a blast furnace plant having a capacity of 1200 tons of pig-iron per 24 hours, the following figures will be obtained:

Gas produced per hour, 8 million cubic feet, equivalent to 680 million British Thermal Units. Gas required per hour to heat the blast, 3,500,00 cubic feet, equivalent to 300 million British Thermal Units. Gas per hour available for power, 4½ million cubic feet, equivalent to 380 million British Thermal Units.

If burned under boilers to generate steam for compound condensing engines it would be little more than sufficient to operate the blast furnace plant, while if used directly in gas engines it would not only operate the blast furnace plant but develop an excess of about 18,000 brake horse power available for 24 hours, that is, 432,000 brake horse power, for other purposes; which latter power if required and developed in compound condensing steam engines would consume about 860,000 pounds of coal; or, in such a plant, the use of steam would be equivalent to an excess in coal consumption of 300 million pounds per annum.

On the continent of Europe the iron and steel works are more largely equipped with high power gas engines than those of England or America, but the engineers in the latter country are investigating this subject closely and are now beginning to utilize high power gas engines extensively on account of the great advantage gained by using the waste blast furnace gases, as well as on account of the wonderful economy due to the extremely high thermal efficiency of these engines. Prominent American engineers have found it to their advantage to make use of the costly experimental work of European engineers, a number of American manufacturing firms arranging to utilize European designs for high power gas engines driving electrical generators as well as blowing engines.



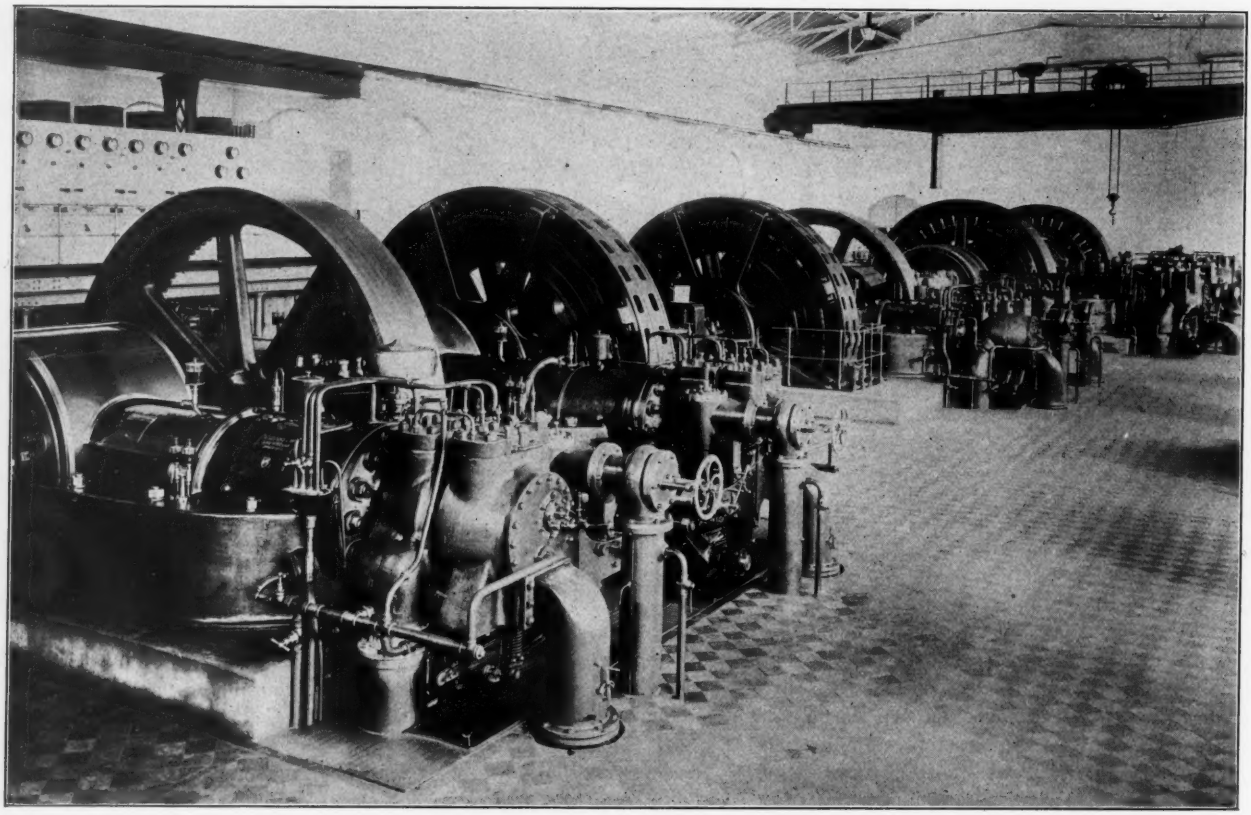
1000 H. P. Oechelhauser Gas Engine operating Alternator at Steel Plant at Differdingen, Germany

At the Micheville steel works, in France, shown on front cover, the electrical power house is provided with Nurnberg gas engines of the single cylinder double acting four cycle type, each having a capacity of 1100 horse power. These gas engines operate at a speed of 100 revolutions per minute and are directly coupled to direct current dynamos, which supply current for operating electrically driven machine tools and labor-saving devices, as well as various other machinery about the iron and steel plant. The engines were installed in January, 1904, and belong to the same type as those manufactured in this country.

At the Eschweiler mine, near Alsdorf, a gas engine electric power plant is in operation which is equipped with two Nurnberg gas engines of the double acting four cycle type, each having a capacity of 500 horse power. These engines are directly coupled to three-phase alternators without flywheels and have a speed of 125 revolutions per minute. The station is also provided with three Nurnberg gas engines having a

capacity of from 1000 to 1200 horse power each driving by direct connection three-phase generators having large flywheels, the speed of the same being 100 revolutions per minute. The a. c. generators supply a 500 volt current which is carried by a power transmission line to the various underground electrically operated machines.

These gas engines are supplied with coke oven gas and are most economical in consumption of fuel. At the Rombacher Huttenwerke, at Rombach, in Lothringen, the blowing engines as well as the gas engine driven electrical generators are located in the same power house. There are three 1200 horse power Nurnberg blowing engines in operation, one of which drives a three-phase alternator by direct connection for power transmission service, while the two remaining engines are directly coupled to continuous current dynamos supplying a current of 220 volts for light as well as for power service. These engines drive the electrical generators at a speed of 107 revolutions per minute. The blowing engines include four units each of 900 horse power operating at a speed of 80 revolutions per minute and delivering 860 cubic meters of air at a pressure of .5 atmospheres, while they can provide a maximum pressure of one atmosphere without difficulty. Another Nurnberg gas engine blowing unit has been provided having a capacity of 2700 horse power at a speed of 90 revolutions per minute, delivering 700 cubic meters of air at a pressure of from 2 to 2.5 atmospheres, this outfit being installed in another power house. All of these engines are operated by waste blast furnace gases. Water cooling is provided for the cylinder piston, piston rod, exhaust valves, etc., of these engines, the main slide also being arranged so that it may be water cooled if desired.



Deutz Gas Engines of 600 H. P. and 1000 H. P. Capacity driving Alternators at Dudelingen, Germany.

Wireless Messages Sent 262 Miles.

The Navy Department at Washington recently announced that ships of the North Atlantic fleet have communicated with one another by wireless telegraph at a distance of about 262 miles. This distance, the Department says, is greatest at which wireless messages have been sent from ship to ship in the navy.

One Million Horse Power Water Power Plant to be Erected near York, Pa.

The McCall's Ferry Power Company have recently acquired valuable railroad and canal properties on the banks of the Susquehanna River, near York, Pa., for the purpose of erecting a large water power plant. These properties were mortgaged for $10,000,000, which money will be used for the erection of the power house and dam across the Susquehanna River. This dam is to be an exact counterpart of the dam on the River Nile, Egypt. The breast will be 32 feet high, and the amount of water flowing over it will be capable of generating 1,000,000 horse power.

To find the steam pressure required to drive a boiler feed pump, multiply the area of the water piston by the pressure in the boiler and add 50 per cent. for friction and necessary difference in pressure to allow the pump to run at the required speed. Divide the result by the area of the steam piston and the quotient will be the steam pressure required.

COST OF HYDRO-ELECTRIC POWER

By George E. Walsh.

The cost of hydro-electric power varies so much in different parts of the country that engineers cannot figure upon even the relative results without a fair knowledge of all the physical conditions of the plant. The installation of large plants, such as Niagara and Massena, represent probably the minimum cost of converting the energy of flowing water into electricity. The supply of large current at a small charge has consequently made these plants typical of their class, and they indicate the potential power of a great waterfall in building up groups of industries dependent upon electrical energy for their development.

But the smaller rivers and streams throughout the country offer hydro-electrical possibilites that must depend upon conditions very dissimilar to those which have made Niagara so successful. The relative cost of developing these streams for commercial purposes presents problems of the greatest importance to engineers and owners of water-courses. The factors which enter into the cost of converting the water power into electrical energy are chiefly those of general construction, the character of the waterfall itself, and the difficulties of transmitting the current to marketable centres.

The character of the stream must always prove the most uncertain factor in developing any small hydro-electric plant. Few of our small streams furnish constant volumes which can be depended upon the year round without considerable artificial construction of dams and reservoirs to control the water. The uncertainty of the fluctuation in the volume of water is so great in many of our streams that their usefulness for hydro-electrical development is greatly impaired. Even such large streams as the Connecticut River show a variation of 50 per cent. in volume of the flow, while many small mountain streams, which otherwise present excellent physical conditions for developing electrical energy at little cost, are practically removed from the field of industrial use because of their erratic flow.

The chief factors in the cost of harnessing a stream are thus the physical characteristics of the river or waterfall. The cost of storing the water in reservoirs so as to preserve a constant volume the year round is sometimes so great that electrical energy can be developed only at prohibitive prices. This is particularly true of small mountain streams. In the Rocky Mountains there are numerous small streams with heads varying from 5,000 to 10,000 feet, but owing to the difficulties of conducting the water to power-houses below, they are practically useless. Where the drop is vertical, the cost of using the water for hydro-electrical purposes is the cheapest, for the penstock need then be little more in length than the actual height. The best illustration of this is the utilization of the waters of Mill Creek in Southern California for forming a part of the 83-mile transmission line to Los Angeles. The power-house is situated in the valley below, and the drop through a height of 1900 feet is almost vertical. The stream itself is small, but owing to its great altitude and steep drop the cost of developing electric power therefrom is insignificantly small. A small stream with such a high head and steep drop is the most economical in existence for hydro-electrical development.

It is a well-known engineering fact that the cost of the development per unit of power of any waterfall or stream decreases as the head increases. Compensation for a lower head must be obtained through the construction of large dam, canal, penstock, reservoir and power-house. The increase in the cost of construction is thus general.

Larger water-wheels and generators are needed for streams with low heads and large dams, for the speed of revolution increases with the head of the water and decreases with it unless compensated for by increased volume of water. To obtain the latter, larger wheels and heavier machinery are demanded in the plant. Thus at Sault Ste. Marie, the head is only twenty feet, and at Canon Ferry, on the Missouri, is thirty feet. The sizes of the dam, water-wheels and electric generators are consequently larger per horse power developed at the former plant than at the latter.

When the head is as low as five or ten feet, the development of electric power becomes a more difficult engineering problem than any of the above, owing to the necessity of increasing the size of the power-house and its equipments. It is usually cheaper to back the water up by dams to secure a higher head than to attempt to use the energy of the water as supplied naturally. By backing the water up and utilizing a higher head from a power-house located directly below it, better and cheaper results are obtained than to build a long penstock or canal with comparatively moderate flow of water. The vertical drop of a cubic foot of water through a height of 100 feet develops 11.2 horse power per minute, not counting the loss through friction and other factors.

This factor of available water-head makes many of our small streams the greatest hydro-electric possibilities in the world. Considering their value in comparison with the large hydro-electric plants drawing their energy from a Niagara, Spiers Fall, or Massena, they present greater opportunities for profit in proportion to the investment made. And yet such streams with high heads are found in considerable numbers in all parts of the East and West. In California their value has been appreciated more than elsewhere, and the transmission of the hydro-electrical energy of Mill Creek, the Yuba and Santa Anna rivers upward of one and two hundred miles to the Pacific coast for industrial purposes represents the highest achievement in hydro-electrical engineering. With comparatively small streams in the Sierra Nevada mountains, but with high heads, the engineers have supplied the coast cities with cheap electric current for lighting, railway use, and mill, factory and mining operations.

In the great Rocky Mountain section of our country there are streams found at altitudes varying from one to ten thousand feet above the sea-level. Many of these reach the Mississippi or ocean by slow gradations, and their harnessing for electrical purposes would have to be accomplished by expensive damming; but on the other hand, a considerable number of these could be inexpensively converted into power facto-

with almost unlimited opportunities. Some of the small streams have available heads of two and three thousand feet, and others with a little engineering work could be converted into water-heads even greater than two and three thousand feet. The power generated by such streams would have to be transmitted in some cases several hundred miles to find a market, and this fact militates greatly against their development. The few streams with such high available heads situated near markets for electric power will naturally be developed within the next decade.

The cost of building hydro-electric plants is thus a subject of wide variation—as wide, in fact, as the difference in their heads of ten to two thousand feet. The cost can be placed anywhere from $50 to $300 per kilowatt capacity of the plants, not including the cost of transmission or distribution lines. The development of comparatively low heads of streams that have a uniform and large volume of water the year round can be accomplished without too great cost in many parts of the country. This has been particularly demonstrated in the eastern part of the country where rivers with an average fall of from five to ten feet per mile have been harnessed for industrial purposes. The majority of the streams have their highest heads in the mountains a considerable distance from the markets, and while it would be cheaper to construct power plants further inland, near the high heads, electrical engineers generally adopt the plan of choosing a site nearer the markets, with lower water-heads, in order to shorten the transmission and distribution lines.

Thus we have on the Housatonic a great hydro-electric plant in the course of construction at Ashley Falls, near Pittsfield, where the river has an average fall of seven feet to the mile. Above this point the fall reaches nine and ten feet per mile, and below Falls Village it has an average fall of over 18 feet to the mile. But owing to the fact that Pittsfield offers an excellent market for electric power, it is considered more profitable to utilize the stream at one of its points where the fall is the smallest. Further down this same river, at Bull's Bridge, a dam has been constructed to back up the water and increase the available head. A fall of water of 110 feet is thus accomplished, and an electric plant has been established to utilize a part of its power.

The Housatonic, like many other of our eastern streams, shows a wide variation in the volume of its flow at different seasons. In the summer and autumn of dry seasons, the volume of water has decreased two-thirds, and the supply thus limits the actual hydro-electric value of the stream without extensive reservoirs to preserve a normal flow. But even at the lowest volume, the available horse power of a stream of this size with a head of 100 or more feet would be sufficient to supply all the needs of an ordinary railway system.

The cost of transmission of power of small plants is of as vital importance as that of installing a power-plant where the available water-head is excellent. With nearby markets to sell current to, the problem is already half solved. But few of our streams with high heads are so located. Most of them are situated well back among the hills or mountains, where industrial plants or towns and cities are scarce. In order to make the investment profitable, the current must be transmitted many miles away to large markets. The cost of developing power from water courses is thus only one of the several elements of the problem.

The commercial limits of electrical transmission cannot be arbitrarily fixed, for the cost of conductors becomes prohibitive in one case at a maximum distance of 50 miles, while in another 100 or 200 miles are not beyond the limits of profitable distribution of the current. With the California power-house at De Sabla sending current with commercial profits to the coast, some 232 miles away, it is not possible to state the exact limits of transmission in any general way. A good deal depends upon the cost of conductors, the right of way, poles, cross-arms and insulators, but probably more upon the cost of horse power at the plant and the amount of voltage that can be generated.

By joining several power-houses on the same line, and drawing energy from several streams or from different points of the same river, long-distance transmission difficulties are partly overcome, and the cost of the work greatly reduced. The general trend now is to operate in multiple several power-houses located a dozen or two dozen miles apart. The longest transmission line in the world, stretching from De Salba power-house in the Sierra Nevada Mountains, California, to the coast, a distance of 232 miles, has no less than five power-houses distributed along the system, while the 83-mile line that runs to Los Angeles has three power-houses connected in multiple. In the East we have a number of similar examples of comparatively long-distance transmission lines drawing their energy from a number of streams, and the opportunities for further development in this direction are almost unlimited. By such methods, the streams of Maine, New Hampshire and Vermont, with an average altitude of 500 to 1500 feet above the sea-level, could in time be made to supply the coast cities with nearly all the power they need. The variation in the volume of the flow would have less effect then in disturbing the supply of energy. By going further back to the sources of supply a higher head would be obtained, and also a larger and more constant flow in volume.

The amount of energy used for sending a high voltage from 20 to 100 miles is generally so great that the power of the plant is exhausted before distant markets can be reached. This limits the commercial transmission of current more than any other factor. For instance, the great Spiers Fall plant has its transmission territory limited to Schenectady and Albany, thirty and forty miles away, because the power required to send the electrical energy that distance is practically exhausted. As the demand for current for mining purposes increases along the line of the long-distance California lines, the difficulties of sending current to the coast will steadily increase, and within a few years it will be impossible to supply the most distant customers without further reinforcements by new power-houses along the route. The commercial or profitable transmission of long-distance currents is thus a question involving many engineering details and considerations of consumption and generation. The consumption of current is more than likely to increase faster than the development of long-distance transmission lines, and the question of how far electrical energy can be sent over lines at a profit may never reach an actual practical test or solution.

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An injector of the lifting type or a pump will not lift water more than about 20 feet, so that if the water supply is below the boilers, the injector or pump must be placed near the supply, as the water can be forced any reasonable height to the boilers.

Oil Extraction.

By R. T. Strohm.

From a thermal point of view, it is always highly desirable to feed hot water to a boiler, in preference to cold water from city mains or exposed reservoirs. This has led to the utilization of returns from steam heating systems, drips from pipe lines, and condensed exhaust steam from engines and pumps. But there has been trouble with the last-named because of the presence of oil in the water, which, when carried over to the boiler, would collect the mineral impurities, forming viscous, sticky masses which would sink to the lower plates of the boiler. When the deposit became so thick as to impede the transmission of heat, there would result overheating of the shell at that point, followed by a bag in the plate.

To avoid this and other attendant evils, a number of devices have been placed on the market, under various names, whose purpose is to remove all oil from the steam or water before it is fed to the boiler. It may be termed an extractor, a separator, an eliminator, or a filter, but in the end its object is the removal of oleaginous matter.

Every good feed-water heater using exhaust steam is fitted with some type of oil extractor. In a number of heaters it takes the form of a series of baffle plates against which the steam current must impinge and by which it is broken up into a number of smaller currents. The baffle plates are intended to catch the oil particles and hold them, and afterward to carry them to a drip pipe or settling chamber removed from the action of the steam. The same idea has been carried out in the greater number of oil separators. These are located on the exhaust pipe.

Yet, even where these separators have been in use, the trouble has at times been apparent. In some way, the oil managed to get into the boiler, making it evident that the separators were not removing all the oil, though they were taking out a great deal. The explanation offered was that the baffle plates, while catching the greater part of the entrained oil, broke up the steam currents and the water and oil globules into a finer form. In other words, the impact of the steam against the plates, together with the eddy currents formed, caused a shattering of the larger oil and water globules, so that they assumed a more finely subdivided state. These smaller particles, being lighter, were more easily carried, and were less liable to be stopped by the succeeding baffle plates, with the result that some of them got through the separator into the hotwell and were pumped into the boiler. As usual, however, it is the occasional case in which a separator fails to do the required work that is held up to public notice, rather than the hundreds of instances in which it is giving perfect satisfaction.

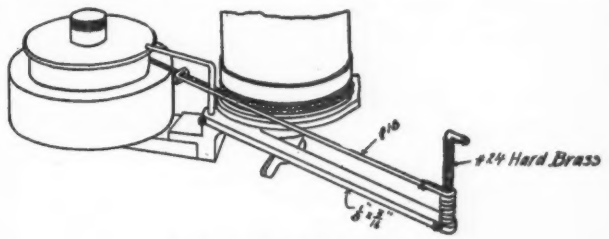
Another way of removing the oil is to pass the feed-water through a filter. It may be made of cloth, coke, sand and pebbles, or hay, depending upon the ease with which these may be secured, or upon the amount which is to be expended in the construction of the apparatus.

Still another method of overcoming the difficulty is to use surface traps and blow-offs. Having a less specific gravity than water, oil will float at the surface in the hotwell and in the boiler. By skimmers, the upper layers of oil and water may be removed from the hotwell; and the pump suction, if attached somewhere between the lowest water level and the bottom of the well, will not be liable to draw in either oil or sediment. A surface blow-off in the boiler is frequently found valuable, but it cannot be denied that it is far better not to allow the oil to enter the boiler at all, than to attempt to remove it after it has been pumped into the boiler.

A Cord Take-Up which Can Easily be Made.

By W. A. Stock

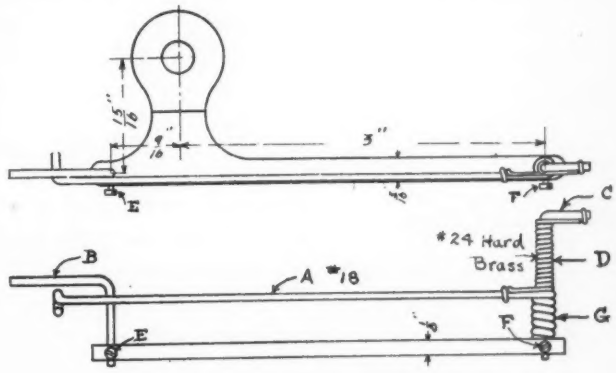
I enclose herewith a drawing of a cord take-up which can be used in connection with a reducing motion. The whole thing is so simple that any engineer can make one at a cost not exceeding thirty cents. It is very convenient and sometimes absolutely necessary, when indicating an engine, to be able to change cards without stopping the engine. This little



Take-Up for Reducing Motion.

device, when used on an indicator which has a reducing motion, allows this to be done. I have used mine up to 250 revolutions per minute and it works perfectly satisfactory. In addition to the perspective sketch, I have added two views which make the drawing almost self-explanatory.

The main piece, XY, clamps under the thumb nut which holds the reducing motion. It is made of ⅛-inch brass but it may be necessary to file this down to $^1/_{16}$-inch where it clamps under the nut. The pieces A, B and C are made of No. 18



Details and Dimensions for Making Take-Up.

brass; the end of A should be annealed before bending into coil G, which should fit close on C. The spring D is of No. 24 hard brass and can be wound cold on a piece of No. 18. The tension on the take-up arm, A, can be regulated by loosening the screw, F, and turning the piece, C, until the required tension is obtained.

The drilling of the holes for the wires, B and C, and the drilling and tapping for the screws, E and F, were done by a jeweler, who also furnished the screws. These screws are about $^1/_{16}$ of an inch in diameter.

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Variable Speed Motors. Since the introduction of the electric motor for the direct driving of machinery, there has been a demand for a motor which can be run at variable speeds under all conditions of service. There are a number of variable speed motors which have been built to answer various purposes but they all seem to have some requirement which is lacking. One arrangement for giving different speeds, which has been used satisfactorily in silk and cotton mills, is known as the comulative winding. The motor in this case is compound wound, the lowest speed being obtained when it is run as a compound motor, other speeds being obtained by short-circuiting portions of the series winding and the fastest speed being obtained by running the motor as a shunt machine with all the series field cut out.

When driving machine tools, such as lathes and drill presses, a larger range of speeds than is obtained by the comulative winding is required, together with non-sparking under excessive loads, constant speed at all loads for which the motor is adjusted, and reversibility. One method which is said to do this satisfactorily is known as the inter-pole method, by means of which sparkless commutation is said to be obtained, the speed can be set at almost any point between the limits and the power output of the machine is constant.

In the usual constant speed motor, the two main causes of sparking are self-induction of the short-circuited coil passing under the brush and the action of this coil in generating an electro-motive force by cutting the lines of force of the armature field. These causes are overcome in part by the resistance of the carbon brushes and by the placing of the brushes so that the short-circuited coil cuts the lines of force thrown out by the main field in such a manner that the main field is used to prevent the lines of force from the armature field to pass out in the region of the short-circuited coil, thus generating such electro-motive force in the short-circuited coil as will aid in the reversal of the current as the coil passes under the brush.

With the variable speed motor, however, these means are entirely inadequate. The reduction of the field strength necessary to obtain high speeds prevents its use in overcoming the magnetic field of the armature. The armature field is, therefore, not only present but the increased speed of the armature makes it become so large that the carbon brush cannot overcome it. The higher speed also increases the electro-motive force of self-induction, so that it becomes impossible for the carbon brush to reverse the current in the short-circuited coil and consequently there is destructive sparking.

This sparking is overcome in the inter-pole method by placing small poles between the main poles and generating a magnetic field independent of the main field of the motor. The inter-poles are provided with coils connected in series with the armature so that the current flowing in the armature flows through the coils of the auxiliary field, thus producing a proper field for commutation. The auxiliary poles produce a field independent of the main field, so that the weakening of the field of commutation caused by an increased load or increased speed is prevented. When the direction of rotation of the armature is reversed, the current in the auxiliary fields is reversed, so that their function is not altered.

The speed of the motor is changed in the usual manner of cutting resistance in or out of the field circuit, in which case the power of the machine, which is the product of the torque and the speed, is constant. If this, or any other arrangement, gives a variable speed motor which will act satisfactorily under all conditions, many problems of direct connected electric drives will be solved.

The Power in Blast Furnace Gases.

The blast furnace, which has sprung into such prominence of late as a means of supply for gas engines, is nothing more nor less than a large gas producer. It differs from the ordinary gas producer only in that the fuel used is mixed with iron and flux instead of fuel with only its comparatively small amount of impurities which are present.

The chemical action which takes place in the blast furnace is more or less complicated, but the gas, which is used in the gas engine, may be said to be formed from the solid fuel as follows: The coke or coal is burnt by the oxygen of the blast into carbon monoxide; this heats the ore to incandescence and reduces the ferric oxide into pure iron by combining the oxygen in it with the surplus of carbon present, also leaving as a product the carbon monoxide gas; any carbon dioxide gas which may have been formed during the process is also reduced to carbon monoxide gas by the excess of incandescent carbon present.

In the ideal blast furnace, therefore, all the waste gases should be composed of carbon monoxide, which by its heat of combustion gives the heat required to do the smelting and which also acts as the reducing agent on the iron ore. In practice, however, only about 80 per cent. of the carbon is oxidized by the blast at the tuyeres.

The carbon monoxide formed, when the blast furnace is in operation, is the combination of carbon and oxygen and is the result of the incomplete combustion of carbon in air and contains the proportion of $1\frac{1}{3}$ pounds of oxygen to every one pound of carbon, forming $2\frac{1}{3}$ pounds of the carbon gas.

It has been figured out that, allowing for all losses, about 10,000 pounds of gas are produced per ton of pig-iron output. From analysis of the gases as they come from the furnace, it has been calculated that there are about 1250 British Thermal Units in each pound of the gas, so that for each ton of pig-iron produced, there are 12,500,000 heat units available in the gases.

From a number of tests made in Germany, which country today has upwards of 150,000 horse power of blast furnace gas engines in successful operation, it has been found that about 25 per cent. of the heat energy contained in the gas can be realized in effective power. Since 2545 heat units are equivalent to one horse power hour and as each pound of furnace gas gives out 1250 British Thermal Units, of which 25 per cent. are available, it is found that $2545 \div (1250 \times 0.25) = 8.12$ pounds of gas are required per hour per horse power.

In the manufacture of the pig-iron, about 18 per cent. of the gases are used in heating the blast so that 82 per cent. are available for use in the gas engine. Multiplying the number of pounds of gas produced per ton of pig-iron by 82 per cent. and dividing by 8.12, the number of pounds of gas required per horse power, the number of horse power available per ton of pig-iron produced per hour is attained, or, $(10,000 \times 0.82) \div 8.12 = 1009$ horse power per hour.

If a maximum allowance of 300 horse power is required to run the blowing engines, pumps for all necessary purposes, including the cooling water for the engines, for handling the raw material and product and for lighting the plant, there still remains about 700 horse power available for other useful work for every ton of iron produced per hour.

A modern blast furnace plant, then, not only requires no fuel for its own power but it should have at least 700 horse power surplus for every ton of iron which it produces per hour.

The Necessity of Thoughtful, Careful Men.

This is an age when time is at a premium and everyone is trying to save the minutes. In fact, this spirit of haste has become so deeply imbedded in the American people that they do everything in a hurry. Haste in some things is absolutely necessary, but in the majority of cases people rush through things simply because they have formed the habit and it becomes quite natural to them.

It is a good plan to economize time, but carelessness is often the direct result of such economy. This is particularly true in the engineering field, where the errors caused by too much haste often remain as a monument of carelessness which cannot be obliterated. Unlike a doctor, who can often bury his mistakes, an engineer is often the victim of them.

The world is beginning to need more men who think deeply and who see where they are going before they take the first step. Haste is not the pilot to the port of carefulness; it leads rather to the haven of destruction. In the great cities, people are forced to hurry because everyone about them is in a hurry, but the city produces thoughtful men as well as the quiet abodes. They go cautiously along the path of life or they could never accomplish their end.

Many a good engineer could ascribe his success to the well-known maxim: "Slow, but sure." This has fallen into disuse today and does not have the significance it used to exercise, but it has often been used as a stepping-stone to success and will continue to be such a stepping-stone for time to come.

This reasoning does not imply that every slow man will be successful. It refers rather to the man who reads thoughtfully and acts carefully and who sees where a step is going to lead him before he takes it. Thus, knowledge combined with carefulness is the keynote to success and we need only glance at the career of some of our prominent men to prove this for ourselves.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

About the Metal Tantalum.

EDITOR THE PRACTICAL ENGINEER:

Your reference to the "new metal" tantalum in a recent editorial on the Tantalum Incandescent Lamp is perhaps a little misleading. While *pure* metallic tantalum has not been separated until quite recently, the metal has been known for more than a hundred years, having been found by Ekeberg, in 1803, in the mineral afterwards called tantalite, obtained from Finland. Works on chemistry describe the *impure* metallic tantalum, which was the only metallic tantalum known until recently, as a black substance with a metallic lustre, insoluble in sulphuric, hydrochloric, or nitric acids, or aqua regia, but soluble in hydro-fluoric acid.

Schenectady, N. Y. GENERAL ELECTRIC COMPANY.

Low Steam Alarm.

EDITOR THE PRACTICAL ENGINEER:

Many engineers say: "Watch your steam gauge," but in our plant we use low steam alarms. I connected my gauge with an electric bell in the following manner:

Take off pointer and dial face and drill a small hole through side of gauge, connecting one wire to pointer post, and run the other through dial and connect to a piece of sheet-copper fastened to face of dial but insulated from it. When the pointer drops back, it forms a contact and thus closes the circuit. The bell is in the engine room so that it will notify the engineer when steam is low and a switch is put in circuit to stop the ringing of the bell until steam is again above the alarm-mark.

Massillon, Ohio. G. W. E.

Kinks.

EDITOR THE PRACTICAL ENGINEER:

I have noticed at different times in your paper, pointers for engineers which were both valuable and instructive. Perhaps some of the following items would be acceptable. I will not vouch for the newness of every one of them but I think that an odd one will be new to many of your readers. A bath often used by marine engineers and firemen is as follows: One ounce of aqua ammonia when added to each pail of water will quickly restore tone to exhausted nerves and strength to a weary body. It makes the flesh firm and smooth as marble. It is a valuable receipt and should be made a note of by all engineers. The following will be found valuable to clean rust from polished steel: Mix 10 parts of tin putty, 8 parts of prepared buckshorn, and 250 parts of spirits of wine to a paste; cleanse the article and finally rub off with blotting paper.

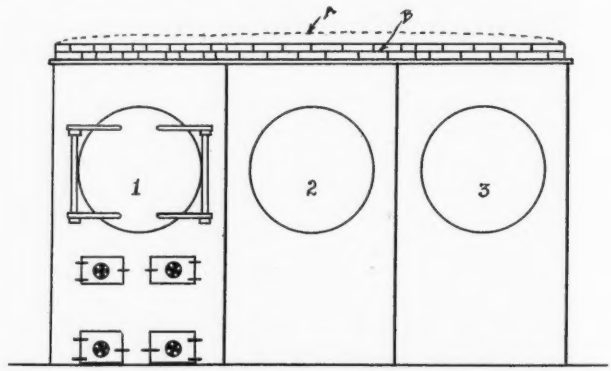
A great many frozen water mains were thawed last winter by electricity, but in many cases the pipes had burst from the effects of the frost, which means that the ground had to be opened up. If there are several feet of frost, or there is even one foot, and it is possible to wait a few hours, the following method of procedure will save a lot of hard work: Cover the surface of the earth where the excavation is to begin, with alternate layers of lime and snow, the lime becomes slaked and heats the soil so effectively that after about 10 hours it can be dug up with the greatest ease. If there is no snow, water can be used.

Toronto, Canada. G. E. NOBLE.

Cause and Remedy of Poor Draught.

EDITOR THE PRACTICAL ENGINEER:

I happened in on an engineer friend of mine, the other morning, just about the time the firemen were finishing their job of blowing the tubes and the fireroom was filled with a cloud of soot. Naturally I asked the engineer how often the tubes had to be blown and he said that of late they had to blow them two and three times on a trick of twelve hours. The engineer also claimed that the cause was due entirely to the poor draught. I questioned him regarding what he had done to aid the draught and he said that he had done everything he could think of. We looked at the clean-out door at the base of the chimney, and the clean-out door at the rear of each boiler, and they were all shut and fastened with a clamp and bolt, and then



Repair to Boiler which Remedied Poor Draught.

cemented around their edges with asbestos cement. Many cracks in the boiler settings were also filled with asbestos cement. We examined the damper in each smoke-flue and the one in the chimney and they were all in good working order.

The boilers, No. 1 and No. 2, as shown in the accompanying sketch, were in service, and No. 3 was down for cleaning. I opened the fire-doors of No. 3 to see if there were any signs of draft there, but the damper was shut tight and no signs of a leak in any part of the brickwork showed at No. 3 boiler. These three boilers were arranged with the double return flue; that is, the flames from the furnace fire pass under the shell to the rear head, then forward through the flues, and from there out over the top of the shell to the main flue leading to the chimney. I suggested to the engineer to have the fireman put in a heavy fire and then suddenly close and open the chimney damper, this he did, and it was surprising how quickly we found where the leak was.

The brickwork forming the return or top flue of the boilers was in bad shape and the mortar had worked out of the joints in many places. The engineer was somewhat surprised at my method of finding the defect in the settings, and straightway wanted to know how it could be easily repaired. I suggested to him to get three or four loads of sand and some loose brick that were lying about the building, and simply lay two courses on their flat, as shown at B, around the entire setting, and then fill this space to the height of 6" with the sand, as shown by the dotted lines at A. This was done, and it was surprising the difference there was in the draught, and not only that, but the sand prevented the heat from radiating out through the brickwork so much, and naturally increased the temperature of the waste gases passing to the chimney, and in that way increased the draught.

Depew, N. Y. C. W. D.

Graphite and "Elbow Grease" Recommended for Cylinders.

EDITOR THE PRACTICAL ENGINEER:

Several times I have had occasion to visit some of the modern engineering plants in and about our city and was very much impressed to see how much cylinder oil was used in internal lubrication of cylinders and I would like to offer a little information on the subject.

I have spent several years in the U. S. Navy and take a great deal of pride in our 1000 horse power triple expansion engines, especially our cylinders and their connections. During about three years, I do not think we used a quart of cylinder oil in the cylinders, but instead, at intervals of about one month's running, we would take off the heads, remove the rings and after cleaning everything thoroughly with kerosene oil, we would rub the cylinders down with dry graphite and "elbow grease" until you could use the walls of the cylinder for looking-glasses.

I found this answered a great deal better than filling everything up with cylinder oil and besides, it kept the condenser tubes clean and the water to the feed tanks pure. So I think that if some of our stationary boys would follow this plan, their boilers would be in better condition, their vacuum higher and grease extractors subject to less usage.

New Haven, Conn. J. F.

Though Theoretically Correct, Practically Wrong.

EDITOR THE PRACTICAL ENGINEER:

The story related by Charles Cloukey, in the July issue, in which he thinks that such a terrific boiler explosion would have occurred had the blow-off pipe stopped leaking or the water supply become unchoked, thus filling the boiler with water after the water had leaked out to a level below the flues, is theoretically correct but practically wrong.

The truth is, that if the water had been raised in the boiler, even though the flues were partly uncovered, there would have been no boiler explosion and if there is any doubt about this statement, I would be pleased to note the proof to the contrary.

It is possible for explosions to be caused by low water and such has been the case, but not when water fell below the upper row of flues in a return tubular boiler. If all boilers exploded that had water below the flue level I am of the opinion that there would not be room in your paper to write all of them up.

It is a matter of fact that the water should be kept above the flues, and it is all right and well to draw the fires if the water should get low, thus preventing the leaking of the tube ends, but this is not evidence that boilers explode because the water falls below the flue level and is again replenished.

In the type of boiler known as the upright or vertical tubular, some manufacturers have gone to a great deal of trouble and expense to produce submerged flue boilers, making great claims for them and arguing that the type not having submerged flues would always be leaking from over-heating.

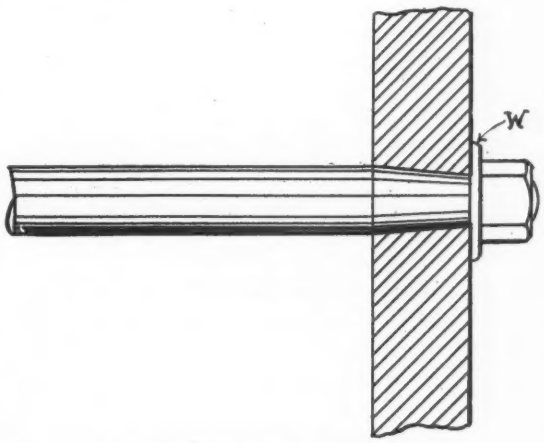
The writer has witnessed a number of these boilers in actual service that proved to the contrary the theory advanced and I have known a number of submerged flue boilers that were continually giving trouble from leaking flue ends. On the other hand, I have known the vertical boiler with full length tubes to be fired as hard as possible and have seen the smoke stack red-hot and never a sign of leak at the tube ends. In fact, I would never buy a vertical boiler with submerged flues and I think the full length flue boiler more efficient. They are also less expensive to maintain and furnish superheat to the steam.

Princeton, Ind. C. C. B.

Curing Knock in High-Speed Engine.

EDITOR THE PRACTICAL ENGINEER:

About a year ago, the cylinder of our 180 horse power Fleming high-speed engine needed reboring and as we had no suitable facilities to do the job as the engine stood, we unbolted the cylinder from the frame and had it carried to a shop in a nearby town, where the reboring was done and a new piston and rings were made.



Cause of Knock in High-Speed Engine.

When we assembled the engine again, it started up and worked nicely for about two weeks, until one night when the load was light and the boiler pressure went to 120 pounds, the engine began knocking so violently that it could be heard 200 yards away. The sound was of high pitch and occurred once per revolution. I stopped the engine immediately and went over every part accessible but found nothing wrong. I questioned the superintendent who had carried the cylinder to the shop about the means used by the machinist to secure the

piston to the rod. He informed me that a 24-inch wrench was used to fasten and secure the nut on the piston rod, and then it was plain where the trouble was.

Taking off the cylinder head, I found that the piston had $^1/_{16}$-inch end play on the rod. On the forward stroke there was a muffled thump, due to the taper fit of the rod in piston but on the back stroke the piston struck its jam-nut with a force of about 12 tons, when working under 120 pounds steam pressure, producing the loud knock.

To cure the knock, I drilled out the key screw, as the end had been sawed off flush, and removed the jam-nut. I then got a large washer, W, $^1/_8$-inch thick, and with a piece of pipe, made a wrench handle 6 feet long; then with a blow pot, I heated the jam-nut, put two men on the 6-foot wrench and set up the nut good and hard and the trouble has not shown up since.

About six months later, there developed a peculiar pound in the nature of a dull, heavy thud that made the building tremble every revolution. For a day or so, it baffled my most diligent search until, when taking off the strap that covers the cylinder bolts, I detected a slight movement of these bolts on one side, when the engine was pulling a load. After going over each nut with a long S-wrench, I set them up hard with a drift and 4-pound hammer and I have had no bother with them since.

Roanoke, Ala. W. O. O.

This Plant Owner was a Mean Man.

EDITOR THE PRACTICAL ENGINEER:

An experience in a boiler room not long ago may be interesting to some of your readers, especially to owners of plants. While night engineer in a manufacturing establishment, I had just changed my clothes for duty, looked at the water gauges of a battery of return tubular boilers and was about to look at the pumps, when in front of one of the boilers, the gasket from a man-hole plate blew out, the steaming water coming like a torrent from the front doors.

Now comes the question of examining boards to applicants: "What would you do in case a gasket from a hand-hole or man-hole blew out?" The answer might be easy but the circumstances are often not considered. In this case, the boiler room was soon at a temperature that was next to unbearable, the floor was flooded with hot water in front of the boilers, the coals acting as a dam to make the water deeper.

There were only two alternatives: one was to run away and save myself and be called a coward, and the other was to get scalded. My first sense of duty was to shut the affected boiler off from the rest by closing the main valve on top of the boiler, the result being in a few days, some new skin on my nose. Nearly exhausted, I ran back to the boiler room and drew the fire, the hot water falling on top of my feet and body. Next, I started the feed pump more lively for a better supply of water to the other boilers. After inhaling a mouthful of fresh air, I went back to open furnace doors and close dampers, discovering that my water was scarce. I stood at my post for fifteen minutes until others were called to draw the fires.

A representative from the firm was sent to inquire about my injuries, which rendered me unable to work for two weeks. I intimated that the owners should consider what I had done to protect life and property and that I took a chance of being blown into oblivion. He made notes of what I said and in a few days called again to have me sign an agreement to accept part of my loss, which was half time for a week and a half.

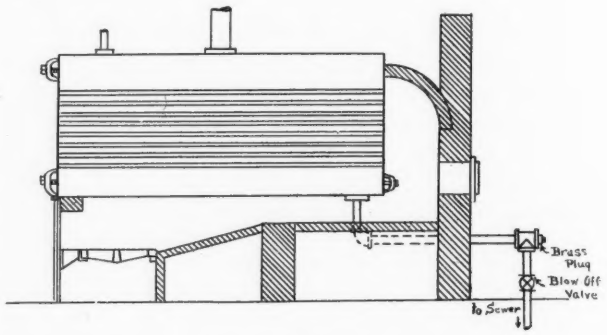
I ask, is this reasonable? I only did my duty but at the same time the services of an engineer when risking his life, through no fault of his own, to save the property of his employers, should be more appreciated. Why is not the stationary engineer and fireman, who risks his life for others and in saving the property of his employers, not considered like the hero of a marine or locomotive engineer who saves his ship or engine from wreck, and why is the credit he receives not the same or considered as important?

Phila., Pa. P. H.

A Better Plan for Blow-off Pipe.

EDITOR THE PRACTICAL ENGINEER:

In reading over the letter of W. Micro, in the July issue of "The Practical Engineer," on "Cause and Remedy of Some Leaks in Boilers," it has occurred to me that it would have been a much better plan to put a tee, with a brass plug in one end, on the blow-off pipe in place of the angle valve, as shown in the accompanying sketch; then put the blow-off cock or valve in the pipe leading to the sewer.



Plan for Blow-off Pipe.

I think it is too much trouble to disconnect the flange every time the boiler is washed, but if there was a tee on the pipe, all that would have to be done would be to remove the plug and if there is any scale in the blow-off pipe a rod could be run into it and the water could also be left running to wash away the scale. This could not be done if the flange of the valve is disconnected to clean out the pipe, as the water will run over the floor.

Milwaukee, Wis. H. J.

Power Calculations of Air Compressors.

EDITOR THE PRACTICAL ENGINEER:

In the June issue there appeared a question in relation to the power of air compressors, and in the August issue there was given an answer, signed J. Tilden, St. Louis, Mo. To H. L. and all others interested in compressors, I will say that the computations are very easy and while the formulas derived are very easy to handle, the derivation of them involves a knowledge of high mathematics. I will go over this subject in detail.

The horse power required to compress 100 cubic feet of air at a temperature of 60 degrees Fahrenheit to 90 pounds pressure is obtained thus: The weight of 1 cubic foot of air is 0.0807 pounds; therefore, 100 cubic feet weigh 8.07 pounds,

when the atmospheric pressure is 14.7 pounds per square inch; hence, at 90 pounds, we have 6.1 atmospheres.

The temperature at the end of compression is obtained by multiplying the absolute temperature at intake by the cube root of the quotient obtained by dividing the number of atmospheres at end of compression by the number of atmospheres at intake. This gives the absolute temperature of the air at the end of compression. Here I will say that the absolute temperature is obtained by adding the constant 461 to the reading of the thermometer. In the above problem, if T′ is the temperature at end of compression, then according to the above rule it becomes

$$T' = (60 + 461)\sqrt[3]{6.1}$$
$$= 521 \times 1.82 = 948.22 \text{ degrees.}$$

Now, the work per unit weight of air is equal to the constant 3 multiplied by T′, multiplied by the quotient obtained by dividing the atmospheric pressure in pounds per square foot by the weight of a cubic foot of air multiplied by the constant 461. This result must be multiplied by the result obtained from subtracting the cube root of the quotient of one atmosphere divided by the number of atmosphere pressures from the constant unity.

In the given case, this becomes:

$$\text{Work done} = (3 \times 948.22)\frac{14.7 \times 144}{0.0807 \times 461}(1 - \sqrt[3]{6.1})$$
$$= 73274.5 \text{ foot pounds.}$$

The above result gives the foot pounds of work necessary to compress unit weight from the pressure of one atmosphere and 60 degrees to 6.1 atmospheres and an absolute temperature of 948.22 degrees.

Since, then, 100 cubic feet of air weigh 8.07 pounds, the amount of work done in compressing 100 cubic feet of air becomes $73274.5 \times 8.07 = 591{,}765.2$ foot pounds. Now this work is assumed to be performed every minute, therefore we get the horse power by dividing this quantity by 33,000, which is $591{,}765.2 \div 33{,}000 = 17.9$ horse power per 100 cubic feet of air. As 1900 cubic feet of air were compressed, we must multiply the 17.9 horse power by 19, which equals 340.1 horse power.

The above volume of air was delivered at 92 revolutions and as the horse power of any engine varies directly as the mean effective pressure and the revolution, the answer at any other speed is one of simple proportion. If, therefore, at 92 revolutions the engine gives out 340.1 horse power, at 74.5 revolutions the engine must give out less in proportion.

That is:

$$92 : 74.5 :: 340.1 : x$$
$$\text{or } x = 275.4 \text{ horse power.}$$

The engineer may inquire what are these constants used. The constant 461 is used to obtain the absolute temperature; for instance, when the thermometer registers 0°, the body still contains heat and if we wish to deprive it of all its heat, the thermometer would register 461 or more correctly, 460.8 degrees below zero, so that all calculations must be worked from the absolute zero. The pressure of the atmosphere is usually taken at 14.7 pounds per square inch, but in most calculations it must be multiplied by 144 to get the pressure in pounds per square foot.

By the above method, any engineer should be able to calculate the amount of work required for any volume or weight of air compressed.

Phila., Pa. C. S. L.

AN ENGINEERING TERM-
"FIRE-IN UP"

Penny Wise, Pound Foolish.

EDITOR THE PRACTICAL ENGINEER:

The letter by Charles Clouky, in your July issue, about the mysterious explosion, calls to mind that some years ago I was night fireman in a plant which had six return tubular boilers, and during the cold weather, any laborer would be put on to keep up the steam during the daytime, or Sundays, so as to keep the shop warm.

When I would go to work at night, I would find the shop cold and some pipes full of ice. I let things go their way for a short time, when one Sunday night, when the weather was very cold, I found the water frozen in the shop and some steam pipes broken from the ice in them. I left everything the way it was and reported it to the manager the next morning. There was a man the next Sunday who knew something about boilers.

If a man had been put on in the first place who knew something about boilers, it would have saved the firm lots of expense and trouble.

Milwaukee, Wis. H. J.

An Appreciative Reader.

EDITOR THE PRACTICAL ENGINEER:

Your letter, giving the answers to the questions which I asked you, received and I wish to thank you for your courtesy in giving me a personal answer. I am sure I never expected you to answer in that manner and I appreciate your action very much. Outside of the fact that you are giving your subscribers the best paper of its kind published, such courtesies on your part are sure to make you plenty of friends.

Hoping that both yourself and "The Practical Engineer" may live long and prosper, I remain

Freeport, Ill. W. P. FLINT.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Why the Holes were Drilled.

EDITOR THE PRACTICAL ENGINEER:

In answer to J. M. C., in the August issue, I would say that the object of drilling the $^{8}/_{16}$-inch holes in the slide valves of the pump was to allow the condensation of the steam to drain through; also if the pump had a habit of stopping under working pressure, it may be that it would blow out the gasket, and by having these valves drilled through they would allow the pressure to be partly reduced.

New Haven, Conn. J. F.

Heating Problems.

EDITOR THE PRACTICAL ENGINEER:

(1). In the laundry where I am engineer, the dry-room is heated by exhaust steam from the engine with three coils which stand upright, one at each end of the room and one in the middle. The clothes put in this dry-room will not get dry for a long time unless a fan is run overhead for circulating the heated air from around the coils. I claim that if the coils were laid flat with the floor, that better results would be had. If the coils were laid flat to cover the entire floor space of the dry-room below the clothes-racks, the heat would radiate upward between all the clothes in the dry-room. If that were done I also claim that running the overhead fan could be dispensed with. Inform me of your views on the matter.

(2). What is the proper proportion of coil-surface to cubic space for laundry dry-room?

(3). Do the coils have to be larger for exhaust steam than for live steam?

Washington, D. C. DE SALES.

(1). If cold air is admitted at the bottom of the room, then the coils would be more efficient if placed along the bottom of the room; if, however, air is admitted at the top of the room, as is done in some systems of overhead heating, then the coils should be placed near the top. It depends more or less upon the circulation of air. If the air in the room has poor circulation, then it would not make much difference where the coils were placed, although the lower part of the room would be better.

Whether the fan can be dispensed with would also depend upon the natural circulation of the air in the room. The efficiency of a heating coil in a closed room is almost zero and the value of the fan is to stir up the air and allow it to strike the hot surfaces of the heating coils, since air is heated by convection. This allows the heating surfaces to give up a larger number of heat units per square foot of radiating surface and these heat units in the air are then, of course, available for drying.

(2). One square foot of heating surface for every 30 cubic feet of room space will give good results if circulation is good.

(3). Practically no difference if steam circulation is good since the total number of heat units in one pound of exhaust steam is very nearly the same as for one pound of live steam. —[Ed.]

Receiver Pressure.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly tell me what the receiver pressure should be on a cross compound engine, 13″ and 26″ by 30″, with one-fifth cut off, initial pressure 150 pounds?

Redlands, Cal. E. P.

The pressure in the receiver depends upon whether the engine runs condensing or non-condensing. If the engins runs non-condensing, the receiver pressure should be higher than when it is run condensing. The accompanying diagram represents the perfect combination of two cards with one-fifth cut

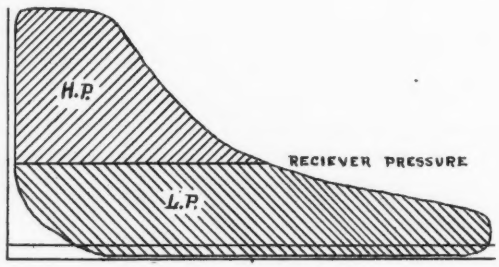


Diagram illustrating Receiver Pressure.

off, condensing to 28 inches vacuum. The line separating the two cards represents the receiver pressure. As a compound engine is usually designed to give out the same horse power in each cylinder, the receiver pressure can be so adjusted by means of the valves that the mean effective of each card when used in the horse power formula will give the desired result. The pressure in the receiver should never be allowed to exceed one-half the boiler pressure.—[Ed.]

Electro-motive Force, Resistance and Current of Batteries Connected in Parallel and Series. Evaporation Problem.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly give me the solution of the following problems through the columns of your paper?

(1). A battery cell has an E. M. F. of 1.2 volts and a resistance of 0.8 ohms; the resistance of the circuit is 1.1 ohms. Which arrangement will give the greater current, 20 cells in series or the same number in parallel? What is the E. M. F., the current and the total resistance in each case?

(2). How many pounds of water at 67 degrees Fahr. can be changed to steam at a pressure of 90 pounds per square inch gauge, by the burning of 7 pounds of hydrogen, assuming that 23 per cent. of the heat of combustion is wasted?

Camden, N. J. D. M. S.

(1). The electro-motive force of the 20 cells in series is $20 \times 1.2 = 24$ volts; when in parallel the voltage would be the same as the voltage of one cell. When the cells are joined in series, the total resistance of the circuit is equal to $1.1 + (20 \times 0.8) = 17.1$ ohms, so that the current in the circuit, when the cells are in series, would be $24 \div 17.1 = 1.4$ amperes.

The electro-motive force of the cells in parallel is 1.2 volts. The resistance of the circuit is $(0.8 \div 20) + 1.1 = 1.14$ ohms, and therefore the current in circuit will be 1.05 amperes. The arrangement of the 20 cells in series will therefore give the greater current in the circuit.

(2). The heat of combustion of one pound of hydrogen is 62,500 heat units; for 7 pounds it will be $62{,}500 \times 7 = 437{,}500$, and allowing 23 per cent. for waste, gives 336,875 heat units as being available.

It will require 1147.9 heat units to raise one pound of water from 65 degrees to steam at 90 pounds gauge pressure, so that the total number of pounds of water changed to steam will be $336{,}875 \div 1147.9 = 293$ pounds when 7 pounds of hydrogen are burned under the given condition.—[Ed.]

Amount of Rope Required for Splicing.

EDITOR THE PRACTICAL ENGINEER:

Kindly give me the length that is allowed for splicing rope used for power. That is, how much longer do you cut the rope than the amount required when the joint is made?

St. Louis, Mo. G. R. S.

The amount of rope required for splicing depends upon the diameter and number of strands in the rope. In general, the longer the splice, the better the joint. For a four-strand transmission rope the following amounts are allowed: For a 1-inch rope, 9 feet; 1¼-inch, 10 feet; 1½-inch, 12 feet; 1¾-inch, 13 feet; and 2-inch, 14 feet.—[Ed.]

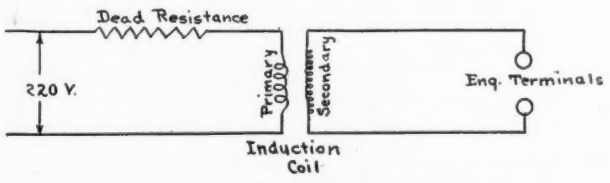
Connections for Gasoline Engine Spark Coil.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly diagram for me some method of connecting a 220 volt direct current circuit for a gasoline engine to replace batteries?

Granstburg, Wis. J. E. M.

Perhaps one of the easiest ways to do this would be to make an induction coil as follows:



Connections for Gasoline Engine Spark Coil.

Make a core of annealed iron wire No. 22 gauge, 12 inches long, 1⅛ inches in diameter. Put four layers of No. 16 wires in the primary and put some dead resistance in series in the circuit to cut down the current. Put about 7 pounds of No. 36 silk-covered wire in the secondary winding and connect the two ends to the terminals on the gasoline engine. The accompanying diagram will show the arrangement of connections. —[Ed.]

Curiosity of the Public.

As a crowd of delegates to the convention of the National Association of Stationary Engineers gathered about a big leather chair, one night, in the lobby of the Seelbach Hotel, these and numerous other expressions were heard, says the *Louisville Courier-Journal.*

"Do you see it?"

"Stop pushing."

"Give it plenty of air!"

"What is it?"

Apparently something of great interest was transpiring near the chair, and the crowd grew rapidly. Those on the outside pushed forward, and those on the inside held the crowd back. Everyone was eager to know what was the cause of the excitement, and the fact that no one could explain increased the curiosity.

In the centre of the surging crowd sat a small man, leaning forward in his chair, pushing three small blocks of wood about the tiled floor with the end of a cane. He was apparently so deeply engrossed in his occupation that he did not notice the crowd about him. Now and then he described a circle about one of the blocks with the end of his cane and made a few mysterious passes. First he would get the blocks in a straight row and then push them carefully until each one was on the corner of a tile and they formed the three points of an equilateral triangle.

As the crowd increased he became more interested in his work, and after gazing thoughtfully at the blocks, he suddenly took a piece of white chalk from his pocket and got down on his knees. He rapidly drew geometrical figures and studied them intently. This was too much for the engineers. They pushed and crowded until those on the outside of the group thought that at the very least some one had fainted.

"He is an inventor," said one, "and he has conceived the idea of some new invention. I think I have seen some of those figures before. I think it is some kind of a valve. Look! he's getting it!"

"He's crazy! Look out for his cane! Stop pushing, give him room!" said another, and those who could not see still demanded to know what was going on. When the crowd had been joined by nearly every one in the lobby, the little man suddenly stood up and smiled.

"Gentlemen," he said, "now that you have proved my theory that curiosity is the strongest human instinct, and that it can be aroused in the most simple manner, I thank you for your attention. I was just sitting here wondering how long it would take to get the attention of every one in this lobby, and I find that I have done it in just two minutes and thirty seconds. I am not an inventor, but merely an advertising man. It is my business to get the attention of the public. So you see what an easy job I've got."

Economy in Heating Draft. The Keller Steam Economizer.

Twelve pounds of air are required to furnish the oxygen to thoroughly consume one pound of carbon, although twice that amount is ordinarily used in steam plants. The air contains by volume four parts of nitrogen and one part of oxygen, but

the nitrogen is useless for combustion. The oxygen of the air, however, will not unite with the carbon in the fuel until the air is considerably raised in temperature. In ordinary combustion systems, cold air is introduced to the fire to supply this necessary oxygen. When air is thus introduced cold to the burning coal, there is a great expenditure of energy of the fuel in heating the air to the temperature necessary to free its oxygen. In a steam plant, therefore, tons of air must be raised each day to a high temperature before it can help in the useful work of combustion. It is therefore clear that every degree of heat added to the air before it is supplied to the furnace is so much energy saved to the fuel and knowing the amount which is evolved by the combustion of a fuel, it is quite possible for us to calculate the amount of energy it will give.

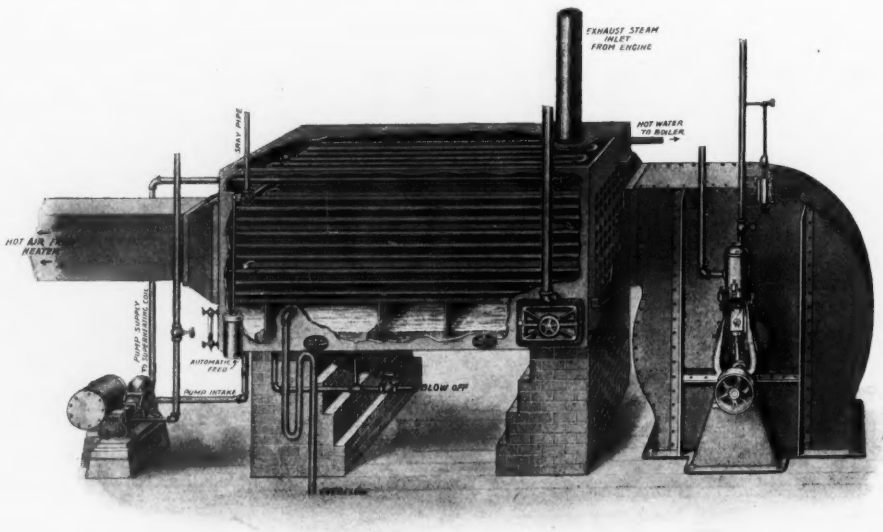
Thus, carbon with 14,500 British Thermal Units per pound would give for each pound consumed 11,204,000 foot pounds of energy. An expenditure of energy at the rate of 33,000 foot pounds per minute is called a horse power, and the work done in one hour will therefore be 1,980,000 units, which is called a horse power hour; it will be seen, therefore, that the combustion of one pound of carbon gives energy equivalent to about 5.6 horse power hour. Any heat, therefore, which is added to the feed water will save energy, as will also any heat that is added to the draft, and every 10 degrees that are added to the temperature of the draft are equal to the saving of 1 per cent. in fuel, the same as in heating the feed water.

The Keller steam economizer, which is a feed water heater and purifier, extracts all the heat from the exhaust and has an attachment for heating the draft, thus furnishing a hot blast for the fire-box under the boiler, or, where liquid fuel is used, raises it to a temperature which affords good combustion.

The construction of the economizer can be seen from the accompanying illustration. The upper chamber contains the superheating coil; in the middle chamber are the condensing and hot air pipes; below is the settling chamber, with projecting and suspended plates for separating the oil from the feed water. The exhaust steam, after entering the economizer, passes over the superheating pipes, thence over the condensing tubes and after circumventing the baffle plates, not only heats the tubes to a high degree but also heats the feed water to the boiling temperature, as it is sprayed from the spray pipe.

Its operation is as follows: Through the medium of a blower, a blast of cold air is forced through the tubes, condensing the steam and at the same time heating the air as it passes through them. The condensation mingles with the feed water and passes to the settling tank. In passing under the suspended plates and over the projecting plates in the pump chamber, all the impurities lodge in the bottom of the tank, where the water has been cooled to about 200 degrees, when the pump takes it out and forces it into the boiler through the superheating coil.

By this arrangement, not only are all the dirt and impurities eliminated, but also all the oil, as the water-line is above the bottom of the suspended plates and as the narrow plates extend above the bottom of these plates, the oil is held back and cannot enter the pump chamber, but is carried off by an overflow pipe, or blown out when the heater is cleaned.



The Keller Feed Water Heater, Purifier, Condenser, Oil Separator and Hot Air Device.

The air as it leaves the economizer is heated to a temperature of 160 to 170 degrees and when utilized as a forced draught under the boiler, it saves just as much fuel as would be required to heat the entering air from the outside temperature to the temperature of the heater, which on the average would be about 100 degrees.

When liquid fuel is used, the Keller economizer is arranged so as to raise the temperature of the oil, before it reaches the fire-box of the boiler, to very near that required to disintegrate the oil into gases. The oil at this temperature burns as readily as a gas, preventing any accumulation of soot in the flues of the boiler and eliminates all smoke.

The hot air as it leaves the economizer is also utilized for heating buildings, drying paper, lumber, woolens and other material and takes the place of the steam piping in a heating system.

This device is manufactured by the Keller Steam Economizer Co., 325 Frico Bldg., St. Louis, Mo., who will be pleased

to furnish any other details of operation and economy as well as a list of testimonial letters from plants where they have been installed.

The Model Flange Clamp.

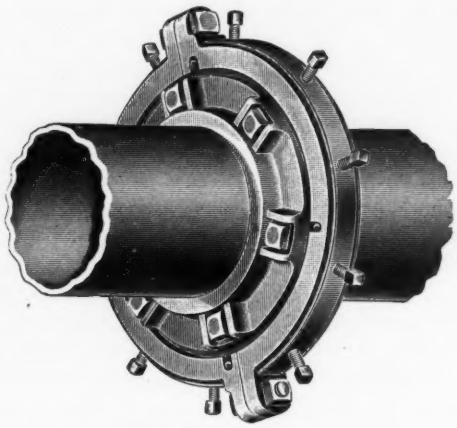
One of the most annoying things in a power-plant, which it is sometimes impossible to avoid, is a leaky flange joint. It often happens that the leak occurs between the pipe flanges at a most inopportune time when it is impossible to shut down

The Model Flange Clamp.

and renew the packing. The result is a hissing joint which must be endured until the joint can be broken, in which case it may necessitate a large expense.

Even if the leak itself is not objectionable, it may happen that the loss of steam from the joint may affect the economy of the plant. This was clearly illustrated recently when an engineer and corps of men were making a feed water test and while in the middle of it a flange joint began to leak and the test had to be stopped until the joint was repaired.

To overcome many such difficulties, James McCrea & Co., of 63 W. Washington St., Chicago, Ill., have put upon the



Clamp in Position on Flange.

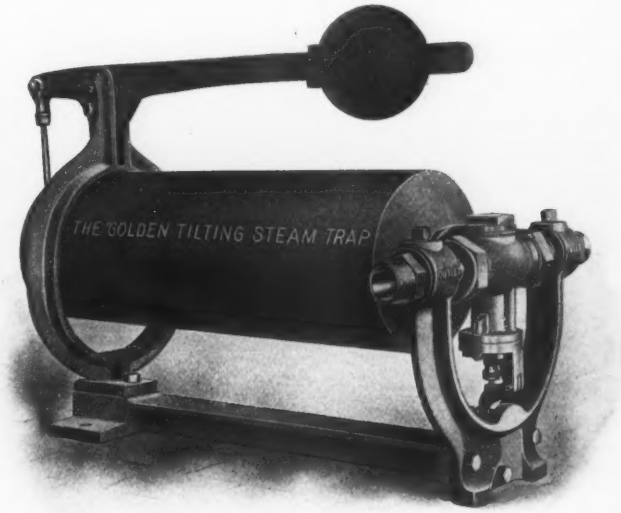
market a flange clamp which will stop all leaks at flange joints. This clamp, which is shown in the accompanying illustrations, can be attached in a few moments with the pressure on the pipe and will repair the leak until it is convenient or advisable to renew other packings on the line, which may be months later, when the clamp can be removed and saved for a future emergency.

The clamp consists of an outer ring made in two sections, in which the compression screws are placed. The compression screws bear against an inner or compression ring, which is made in four sections, with a lug on each section to correspond with a slot in the outer ring, thus assuring no displacement while attaching. The gasket, which is placed around the flanges over the leak, completes the outfit.

By means of the inner rings, it is possible to get an equal pressure on the circumference of the flange when screwing up on the compression screws. The flange clamps are painted to protect them from rust and are furnished with packing ready for use. In ordering, it is only necessary to give the exact outside diameter of the flanges.

The Golden Tilting Steam Trap.

There is hardly a steam plant in existence which does not contain one or more steam traps for collecting and discharging the condensation in steam pipes, separators, etc., and for this reason it is one of the most important accessory devices in a modern steam plant. To work effectively, a steam trap should be durable and efficient and should be so constructed that the chances of its getting out of order are a minimum.



The Golden Tilting Steam Trap.

A steam trap which possesses these features is shown in the accompanying illustration. The water of condensation enters through the feed trunnion and passes into the receiver. When a sufficient amount has entered the receiver, it causes it to tilt; which opens the auxiliary valve, allowing the pressure to act on the piston. The piston opens the main valve and allows the water in the receiver to discharge through the outlet in the trunnion through the full area of the discharge valve. After the water has been discharged, the balanced weight on the lever causes the receiver to "tilt" back to its filling position, which releases the auxiliary valve, allowing the main valve to close.

The trap does not contain any floats, valves or buckets inside

of it, all the working parts being on the outside. It can be used for high and low pressure and all the parts are bronze and removable. If the trunnions require tightening, a wrench is not necessary, since the nuts can easily be turned by hand.

For further information pertaining to this interesting device, address the Golden-Anderson Valve Specialty Co., 115 Pike St., Pittsburg, Pa.

The American Oil Filter, "Unit" Type.

The tendency of power plant construction at the present time is toward very large plants which require oil filtering apparatus of large capacity, but which at the same time occupy a comparatively small space. To satisfy this demand, the Burt Manufacturing Co., of Akron, Ohio, are making an oil filter to answer these requirements, known as the American Oil Filter, "Unit Type," a sectional view of which is shown in the accompanying illustration.

Sectional View of "Unit Type", American Oil Filter.

Each unit is so constructed that it can be used in connection with, or independent of, an oiling system, so that in case additional machinery is added to a power plant at any time and increased filtering capacity becomes necessary, any number of units can be added and they can either be operated together as one filter, or separately, as desired, without in any way changing the pipe connections.

By referring to the accompanying cut, the operation of each unit is as follows: The dirty oil enters the waste oil receptacle and passes through the small perforations, flowing thence horizontally to the two filtering cylinders, and in passing to these cylinders, the heavy impurities fall by gravity into the sediment pan and therefore do not clog up the filtering cloths or filtering material. Each cylinder is wrapped with a cloth through which the oil must pass before entering the filtering cylinder.

After passing through a quantity of animal bone black, the oil passes down through the two tubes into the bottom of the filter. By means of plates attached to the bottom of the tubes, the oil is spread out in a very thin film and is thoroughly washed by the water, and any remaining impurities in the oil drop to the bottom of the filter and can be flushed out at any time desired by simply opening the gate valve, which connects to the sewer.

A special patented feature of the American filter is the hot water chamber, located in the upper part, which heats the oil before filtering. The object in heating the oil is to cause it to flow more freely, thus increasing the speed of filtration and the filter capacity. When dirty oil is heated, it spreads out and most of the dirt and grit then falls into the sediment pan, where it can readily be removed without interfering in any way with the pure oil for the oiling system. By heating the oil in this manner, the filter will handle the heaviest grades of oil, such as lard, crank case, cylinder and gas engine oils.

These filters are so constructed that they can be used with or without an oiling system; the only addition necessary when used with an oiling system is the piping of the system itself. Although the filtering chamber is filled with animal bone black, any kind of filtering material can be used in the cylinder, such as white waste, sponges, excelsior or raw wool, but as animal bone black is used in all oil refineries to purify lubricating oil, it is considered to be the most suitable filtering medium. It can be washed out with hot water or gasoline and used over and over again, involving practically no expense for filtering.

In cleaning the filter of the "Unit Type," it is not necessary to shut down the whole system and disconnect the pipe connections. If more than one unit is used, all that is necessary is to shut off the flow of oil to the filter to be cleaned, allowing the other filters to handle an extra amount. When one filter only is installed, it can be cleaned by removing the cloth around one cylinder, and if the filtering material also needs to be removed, the cylinder can be unscrewed and a plug, furnished for the purpose, screwed into the tube so as to keep the dirty waste oil from flowing into the filter. The other cylinder will continue in operation while the first is being cleaned. The filtering material can thus be changed without stopping the supply of pure oil and it allows the oiling system to remain in continuous operation for supplying the different bearings.

As used in connection with oiling systems, the oil is fed to the different bearings by gravity from the overhead oil reservoir and after passing through the bearings, it is piped to the oil filter or filters in the basement. After being purified, it is again pumped to the reservoir, making the process automatic and continuous and always giving the bearings a liberal supply of oil.

This filter can be used not only in steam engine plants but can be used with gas or gasoline engines of large capacity, the hot water from the engine cylinder being used for heating the oil. In steam turbine plants, where an exceptionally large quantity of oil is used, the oil, being very thin from the effect of the heating coil, will filter rapidly, thus increasing the capacity of the filter.

Twenty-Fourth Convention of the National Association of Steam Engineers

When it was decided to hold the twenty-fourth annual convention of the National Association of Steam Engineers in Louisville, Ky., on August 1st to the 5th, this year, it was predicted that the convention would be successful both in point of the number of delegates present and in the exhibition of machinery and engineers' supplies. That it was one of the most successful conventions ever held by the N. A. S. E. is the universal expression of all of the returning delegates and even its most optimistic supporters did not anticipate the crowds that swarmed in from all directions.

Royal D. Tomlinson—Newly elected President of the N. A. S. E.

The delegates began arriving a few days before the convention and when the first meeting was called to order by B. N. Grosvenor, chairman of the local committee, over 344 delegates had registered their names and were in attendance.

The convention was held in Scottish Rite Cathedral and was opened on Tuesday, August 1st, with an invocation by the Rev. F. C. Witthoff. In the absence of Governor Beckham, of Kentucky, Hon. H. V. McChesney, Secretary of State, delivered an address of welcome, which was plentifully sprinkled with humor. He eloquently described the important work the stationary engineer was engaged in, and retired amid loud applause.

National President Clare F. Wilson responded to the address of the Secretary of State, in the course of which he referred to the aims and objects of the N. A. S. E. Mr. Paul Barth, President of the Board of Aldermen, welcomed the delegates to Louisville and presented the freedom of the city to the delegates. As symbolic of what he said, he presented the convention with a large gilded key which, he said, placed everything at the disposal of the delegates and visitors. National Vice-President R. D. Tomlinson responded to Mr. Barth's address and said that the success of the N. A. S. E. was principally due to the technical ability of each engineer who was a member.

President Wilson then took the chair and before he had time to call the convention to order, he was presented with a handsome gavel by Robert Anderson, of Milwaukee. Past National President, P. H. Hogan, also presented Bro. Wilson with a gavel composed of wood from the Hawaiian Islands, in behalf of Chas. M. Eddy, President of the National Supply Men's Association. A large bouquet of handsome flowers was then presented to President Wilson with the compliments of the National Ladies' Auxiliary, by Judson Pratt, of Cincinnati.

President Wilson then presented in behalf of the Chicago delegates, a gold and diamond Past President's jewel to J. W. Lane, Jr., who responded with a speech of thanks, after which the following convention committees were announced: Referendum, E. E. Pruyn, J. J. Calahan, J. J. Workes, J. M. Williams, and W. S. Nixon; Auditing, J. F. McGrath, Jacob Reitz and F. H. Yeager; Ways and Means, G. F. Duemler, Willis Lawrence, A. K. Jackson, A. C. Adams and J. F. Connell; Ritual, C. F. Roth, S. W. Corwin and C. F. Parkinson; Mileage, C. W. Naylor, Hood Pitts, D. W. McCarthy, W. H. Bridges and J. E. Kelley.

The Winning Colors.

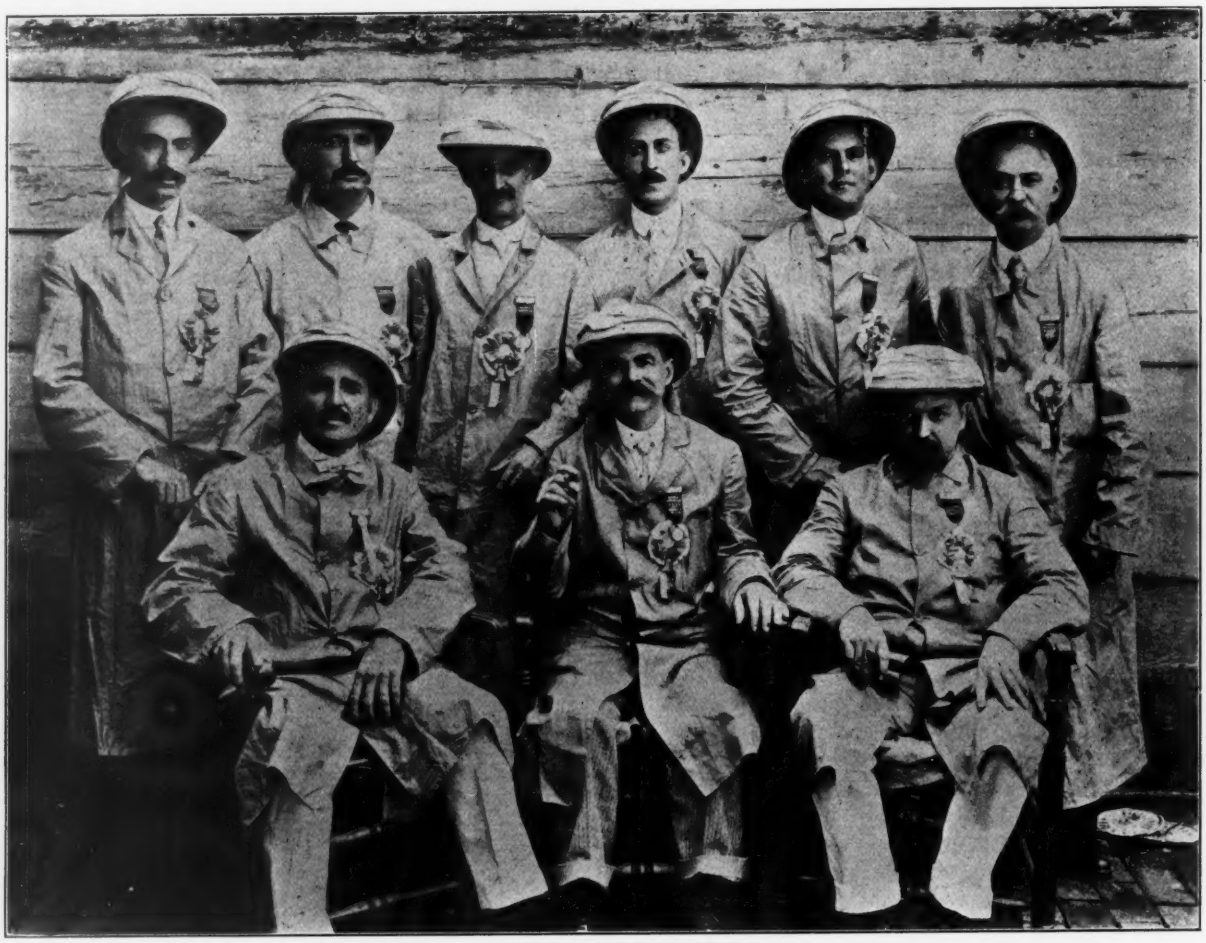
In the afternoon, after the convention was called to order, President Wilson delivered his annual address, which was full of good points for maintaining and increasing the usefulness of the organization. The Secretary's report was received; National Deputy, R. D. Tomlinson reported on the work in different States; the Committee on Education reported the prize winners for the most successful educational works, as follows: First prize, $50.00, to New York, No. 15; second prize, $25.00, to Massachusetts, No. 9; third prize, $15.00, to

Illinois, No. 17. The Committee on Credentials reported 350 delegates and 42 alternates present. C. W. Snyder, of Philadelphia, spoke on the value of State Associations, after which the convention adjourned until Thursday morning.

The exhibit of the National Supply Men's Association was formally opened on Tuesday afternoon, at Liederkranz Hall. The exhibits were attractively arranged on the main floor and basement and included a fine display of engineering appliances and supplies. About 80 firms were represented. An orchestra on the stage played a number of popular airs while the delegates were inspecting the exhibits.

land, Ore.; and Philadelphia. The Philadelphia delegates, consisting of Richard Pape, Chas. E. Coburn, Chas. W. Snyder, V. L. Rupp, Albert Winther, Jas. S. Gillespie, M. J. Malloy, C. H. Rostron and G. T. Duemler, set forth the glory of their city and painted the many advantages of the Quaker City so well that they captured the convention for 1906. They did not do this without a lot of hard work and when in their working uniform, they attracted the attention of the ladies, to whom they gave badges and all kinds of literature and therefore the ladies were unanimously in their favor.

During Thursday afternoon, the ladies were given a delightful trolley ride around the city, visiting all the points of interest and parks in the vicinity. In the evening a grand ball was given at the Masonic Temple, which was the delight of the many well gowned ladies present.



Philadelphia Delegates, who by their tireless efforts, captured the next N. A. S. E. Convention for Philadelphia.

C. E. COBURN C. W. SNYDER AL. WINTERS V. L. RUPP C. H. ROSTRON M. J. MALLOY
G. F. DUEMLER JAS. S. GILLESPIE RICHARD PAPE

Tuesday evening and all of Wednesday were devoted to enjoyment. A fine vaudeville entertainment was given at the Masonic Temple theatre on Tuesday evening, while on Wednesday, a large number of the delegates took advantage of the exceptional opportunity for visiting Mammoth Cave, the party not returning until late in the evening. Refreshments, both going to and returning from the Cave, were served by the National Supply Men's Association.

Business was resumed at 9.30 on Thursday morning, with President Wilson in the chair, and was devoted principally to reports of committees. The principal business in the afternoon was the selecting of the next convention city. The cities in the field were Columbus, Ohio; Kansas City, Mo.; Port-

On Friday morning, the election of officers took place, with the following results: President, Royal D. Tomlinson, of Milwaukee, Wis.; Vice-President, Theodore N. Kelsey, Lowell, Mass.; Secretary, F. W. Raven, Chicago, Ill.; Treasurer, Hugh Rensford, Cincinnati, Ohio; Trustee for five years, Chas. H. Garlick, Pittsburg, Pa.; Trustee for three years, to fill the unexpired term caused by the resignation of Joseph F. Carney, J. H. Van Arsdale, St. Louis, Mo.; Conductor, B. N. Grosvenor, Louisville, Ky.; Doorkeeper, Wm. Speck, San

Francisco, Cal. At the conclusion of the election, President Wilson was presented with a Past National President's jewel.

The newly-elected officers were installed by J. W. Lane, Jr., and as it had been previously decided to change the time of holding the convention from August to September, the convention adjourned to meet in Philadelphia, September 11, 1906.

As a fitting climax to one of the most successful conventions ever held, a large chartered boat took everybody on a sunset excursion for a ride on the Ohio River. There were music, dancing and refreshments in plenty and when the last parting word was said it usually ended: "Meet you in Philadelphia next year."

The election of officers of the National Supply Men's Association resulted as follow: President, John D. Jones; Vice-President, John Carson; Secretary, James McGilvray; Treasurer, Henry F. Weinland; Executive Committee, Herbert E. Stone, G. D. B. Van Tassel and Fred L. Jahn.

The retiring President, C. M. Eddy, was presented with a handsome cut glass buffet set, in behalf of the members of the Supply Men's Association. Past President Charles Martin made the presentation speech, in which he eloquently referred to the capable and efficient manner in which Mr. Eddy had served the organization during his turn in office.

THE EXHIBITS.

The Stayman Manufacturing Co., of New York City, had on exhibition their interesting line of specialties, among which were their self-expanding engine pistons, piston valves, pump pistons, cylinder reboring machines and metallic rod packings. The advantages of each of these were clearly explained by Mr. C. A. Weymouth, president of the company, and Mr. J. A. Scott, chief engineer.

Adam Cook's Sons were represented by Mr. G. S. Tanberg. Their exhibit consisted of various sized packages of Albany Grease, amid decorations of red, white and blue.

The William Powell Co., of Cincinnati, O., exhibited their line of "White Star" valves together with their "Cyclone" blow-off valve, lubricators, oil cups, injectors, etc. Mr. Chas. E. McFarlan, vice-president of the company, was in charge.

The Lunkenheimer Co., of Cincinnati, O., represented by Mr. Wm. Schmidt, Jr., exhibited a complete line of valves, oil pumps, water gauges, lubricators, whistles, injectors, pop safety valves, etc.

The Mason Regulator Co.'s exhibit was at the left of the hall entrance and consisted of Mason reducing valves, pump pressure regulators and other steam regulating devices. Mr. Frank Morrison was in charge.

The Garlock Packing Co., of Palmyra, N. Y., showed an extensive line of packings for all purposes. Their representatives included Mr. C. H. Hancock, of Chicago, Mr. D. Wells, of St. Louis, and Messrs. I. C. Hibbard and J. M. Chapman, of Cleveland.

The Pennsylvania Rubber Co., of Jaenette, Pa., exhibited their well-known Century white sheet packing. Mr. Hudson Dickerman, who is the inventor of Century packing, was in charge of the exhibit.

The Lagonda Manufacturing Co., of Springfield, Ohio, had a large exhibit of Weinland boiler tube cleaners and steam specialties, among which were the Lagonda damper regulator, the Lagonda tube cutter and motor-driven reseating machine. Messrs. H. F. Weinland, J. V. Davidson and Robert Gregory entertained the delegates and their friends.

Jenkins Bros. had a fine exhibit of their extensive line of valves, 96 sheet packing, gasket tubing and other specialties. Their respresentatives on the floor were Messrs. E. L. Buckley, C. L. Waite, Chas. W. Martin, Jr., and A. C. Langston.

The Peerless Rubber Manufacturing Co. occupied Booth No. 1 with a most tastefully decorated exhibit of their well-known brands of packings, among which may be mentioned the Rainbow sheet packing, indestructible white sheet packing, peerless piston packing, Honest John hydraulic pump packing and Success piston packing. Messrs. Chas. Garlick, Jr., J. L. McGilvray and P. G. Staunton did the honors.

The Harrison Safety Boiler Works, of Philadelphia, were represented by Messrs. C. B. White and I. C. De Haven, in their booth, which contained many photographs showing the application of the Cochrane heater and Cochrane separator and the Sorge-Cochrane system for heating and purifying boiler feed water.

The Atlas Engine Works, of Indianapolis, has a four valve cylinder of their Atlas engine on exhibition, which was explained by Messrs. T. J. Moore, B. J. Marshall, Albert Canine, John A. Bechtel and T. E. Keegan.

The Pennsylvania Metallic Packing Co., of Pittsburg, had an exhibit of various styles of packings, in charge of Mr. Thomas C. Greene.

The Indicator Instructor Co., of Newark, N. J., had an exhibit which interested the engineer. The "Simplex" and "Excelsior" indicators, the "Lippincott" reducing wheel, the "Lippincott' latest improved planimeter were exhibited, and the delegates were entertained by Messrs. H. J. Mistell and C. B. Hollister, vice-president of the company.

The Quaker City Rubber Co., of Philadelphia, exhibited various brands of packing, including their well-known Daniels' P. P. P. rod packing and ebonite sheet packing. Mr. A. D. Thompson had charge of their exhibit.

The Liberty Manufacturing Co.'s exhibit was in charge of J. B. Pell and J. J. Connelly. They showed many samples of scale indicating the efficiency of the Liberty tube cleaners. The Faber blow-off valves were also examined with interest.

The H. W. Johns-Manville Company exhibited samples of asbestos packing and pipe covering, in charge of Messrs. C. E. Wehr, G. W. Semple and W. F. Taylor.

The Dearborn Drug and Chemical Works exhibit represented the height of decorative art. It was crowded with delegates and their friends, who were entertained by Messrs. C. M. Eddy, treasurer of the company, Dan Delany, manager Cincinnati office, P. H. Hogan, manager Boston office, Frank Eardley, of Buffalo, W. O. Clark, of Indianapolis, and Jim Beckerley, of Chicago.

The Cling Surface Co., of Buffalo, N. Y., gave practical demonstrations of their belt dressing, at their booth. Mr. W. D. Young, secretary of the company, did the honors.

The Ashton Valve Co., of Boston, Mass., had an interesting exhibit in charge of Mr. Columbus Dill. Their display included the well-known Ashton pop safety valves, Ashton steam gauges and recording gauges, cylinder relief and water relief valves and a complete line of specialties.

Green, Tweed & Co., of New York, exhibited their Palmetto packing and the Favorite reversible ratchet wrench. Messrs. H. S. Demarest and B. W. Ham were on hand to entertain the delegates and visitors.

James L. Robertson & Sons, of New York, had a fine exhibit on the main floor. All their well-known specialties were exhibited, including "Eureka" packings, the Robertson-Thompson indicator, the Willis planimeter and the Hine eliminator.

The International Correspondence Schools of Scranton, Pa., had an interesting exhibit. Mr. J. D. Jones and Mr. John J. Hurley, who were in attendance, gave out much valuable information regarding the system and methods employed at the school.

Geo. W. Lord Co., of Philadelphia, Pa., manufacturers of Lord's boiler compounds, had one of the most attractive exhibits at the convention. Their booth was crowded with engineers interested in the removal of boiler scale. Many testimonials from engineers all over the country were conspicuously displayed all around the booth. Mr. Lyman P. Clark and Mr. Edward McCarthy were in attendance.

The New York Belting and Packing Co.'s exhibit deserves special mention. It consisted of samples of packings, gaskets, moulded goods, air brake and steam hose and was in charge of Mr. L. L. Taylor.

The Watson & McDaniel Co., of Philadelphia, Pa., who always have an attractive display at N. A. S. E. conventions, were very much in evidence with their well-known line of reducing valves, exhaust pipe heads, ejectors, separators, pump regulator and the McDaniel improved steam trap. Mr. Fred L. Jahn received the visitors and his fellow-members.

McLeod & Henry Co., of Troy, N. Y., showed a complete boiler setting in which the advantage of using their steel mixture was shown. The company was represented by Mr. John H. Foote.

Among the other exhibitors may be mentioned: The Underfeed Stoker Co., of Chicago; A. W. Chesterton & Co., of Boston, Mass., who had a display of packings and tube cleaners; the Strong, Carlisle and Hammond Co., of Cleveland, O., with their display of steam traps and water columns; Power Specialty Co., of Detroit, Mich., who displayed a steam flue blower; the Goodyear Tire and Rubber Co.; Loew Supply and Manufacturing Co.; James Bonar & Co.; Keystone Lubricating Co., of Philadelphia; Crane Co.; The Williams Gauge Co., of Pittsburg, and the Republic Rubber Co., of Youngstown, Ohio.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The C. A. Dunham Co., Inc., Marshalltown, Iowa, manufacturers of the popular steam traps for all services, report being nearly swamped with orders for their C. I. heating trap, and have had to add to their facilities in order to keep up with the demand. This trap, because of its size and exceptional efficiency, is being adopted by heating contractors for both low-pressure and vacuum heating systems, wherever introduced, and is guaranteed to work upon variable pressure systems containing oil and foreign matter without re-adjustment.

Through the popularity of this trap for low-pressure heating work, this company has introduced a novel feature in their business by incorporating a drafting department where plans and specifications covering new heating systems, or the remodeling of defective ones, will be gotten out for possible customers free of all charge.

We have recently received from the Burt Manufacturing Co., of Akron, Ohio, a very handsome catalogue which describes in detail the various oil filters and exhaust heads manufactured by this company. The Burt Manufacturing Co. are the largest manufacturers of oil filters in the world, and their new catalogue has been conceived and executed on a scale which accords with their reputation, as it is said to be the largest and handsomest catalogue of this class of goods which has ever been issued. It illustrates and describes the "Cross," "American," and "Warden" Oil Filters, the "American" Oil Filtering System, and the "Burt" and "Standard" exhaust heads.

The information which it contains in reference to the filtering of oils makes it a valuable reference, worthy a place on the desk of anyone operating a power plant. It also describes fully the "Unit Type" of oil filters, which is used in connection with the American Oil Filtering System. Everyone interested in the running of a power plant is invited to write the Burt Manufacturing Co., 204 Main st., Akron, Ohio, for a copy.

Lippincott Steam Specialty and Supply Co. have sent us their new catalogue, which describes the following steam specialties: Lippincott Engine Indicator, Reducing Wheel and Planimeter, Steam Separator and Oil Extractor, Shaking Grate and Furnace Blower, Recording Gauge, Damper Regulator, Feed Water Heater, Steam and Belt Pump, Force Feed Lubricator, Three-way Cock, Indicator Piping, Exhaust Head, Oil Filter, Sheet and Piston Packing.

They state that they are making special efforts in the line of indicating instruments, and that they believe they are making these instruments in larger numbers than have ever before been manufactured at one time.

For a limited period they are sending to each inquirer a set of their engraved Indicator Scales, in a neat vest pocket case. We would suggest that all engineers interested should write for this catalogue. Mr. Lippincott also calls attention to recent improvements in the Simplex Indicator which he is giving away with his correspondence course of Indicator Instruction.

In writing for the catalogue and prospectus of Indicator Course, address A. C. Lippincott, Green and Columbia Sts., Newark, N. J.

The Wm. Powell Co., of Cincinnati, O., have just issued a booklet illustrating and describing their well-known "White Star" Valves. The special features of these valves are the reversible, regrinding, and renewable properties. The discs are made of special metal; they have duplicate wearing faces and they carry their own lock bar for regrinding. For fifty years, Powell products have been before the engineering public and anyone not acquainted with them should write for the above-mentioned booklet.

Palmetto Twist Packing. Under this title, one of the most useful additions to an engineer's supplies is finding steadily increasing sale. It is intended for the packing of valve spindles, small rods, etc., formerly effected by means of cotton wick or asbestos, doped with grease and plumbago. Palmetto Twist Packing, as its name implies, is a twist or yarn of fibrous substance, consisting of several separate and easily separable strands, impregnated with a durable lubricant of high fire test and each a complete packing in itself. For a small valve spindle or rod, a single strand makes a complete packing, for larger sizes several strands can be used. It is claimed by the manufacturers that the material of which the packing is composed, ensures retention of resiliency, resistance to heat and pressure and a tight joint with the least compression, all features that peculiarly fit it for the purpose for which it is employed. It is free from tendency to pack hard, score rods, burn, char or blow, displayed by non-elastic packings, while the convenient form in which it is supplied—in pound spools of 40 yards—and the fact that it keeps indefinitely and is always ready for use, recommend it. The manufacturers, Green, Tweed & Co., 17 Murray St., New York, will send a sample spool free.

Among the latest additions to the already large force of the Dearborn Drug and Chemical Works in New York and their other Eastern branches, is Mr. Jos. F. Hammill, second national Vice-President of the I. U. S. E., and formerly business manager of Local No. 20, I. U. S. E. Mr. Hammill is very prominent, and well-known in New York and the country in general for his earnest work in the engineering world. Mr. William Schatz has also joined the Dearborn forces, and has taken up his new line of business with his natural energy and force, and will undoubtedly make a great success. Mr. Schatz has been connected with the large street railway power houses in and around New York, and is recognized as an operating engineer of ability. Messrs. Hammill and Schatz have our best wishes for their success in their new line of work, and we congratulate the Dearborn Company upon the excellent sales and mechanical department they are building up in the East.

The regulation of steam, air and water pressures enters to an increasing extent into modern engineering and industrial operations, with the growing tendency in favor of central power generating plants. To obtain the full benefit of this centralization of power, means for reducing the pressure of air and steam, from the high pressures most economical for distribution, to the lower, practicable working pressures, must be employed. The pressure regulators manufactured by the Foster Engineering Co., Newark, N. J., have proved exceptionally successful for this purpose. Their "Class W" Pressure Regulator is a standard device, in which the valve governing the pressure is controlled and operated by the movement of a diaphragm, opposed to the action of springs, whose tension is adjusted according to the delivery pressure to be maintained. This pressure is entirely independent of pressure in the supply pipe. The regulator is delicately accurate, positive and reliable and is in successful use in many manufacturing establishments, mines and other places where power, steam or compressed air, distributed from a central source, requires regulation and reduction.

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202-210 South Water Street, Chicago, Ill.
634 Smithfield Street, Pittsburg, Pa.
1601-1615 17th Street, Denver, Colo.
220 South Fifth Street, Philadelphia, Pa.
17-23 Beale Street and 18-24 Main Street, San Francisco Cal.

20th Street and Railroad Avenue. Birmingham, Ala.
1221-1223 Union Avenue, Kansas City, Mo.
709-711 Austin Avenue, Waco, Texas
51-55 North College Street, Charlotte N. C.
Corner Ninth and Cary Streets Richmond. Va.